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Preparation of Planning and Study Documentation

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Ministry of Transport and Communications

PLANNING – STUDY DOCUMENTATION MOTORWAY IN CORRIDOR Vc

LOT 2: SECTION DOBOJ SOUTH (KARUŠE) – SARAJEVO SOUTH (TARČIN)

ENVIRONMENTAL IMPACT STUDY PHASE II

SUBPHASE – ENVIRONMENTAL IMPACT STUDY

NON-TECHNICAL SUMMARY

IPSA Institute, Sarajevo

Sarajevo, July 2006

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LOT 2: SECTION DOBOJ SOUTH (KARUŠE) – SARAJEVO SOUTH (TARČIN)

ENVIRONMENTAL IMPACT STUDY - PHASE II

SUBPHASE – ENVIRONMENTAL IMPACT STUDY: NON-TECHNICAL SUMMARY

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ENVIRONMENTAL STUDY IMPACT
NON-TECHNICAL SUMMARY

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Content: **NON-TECHNICAL SUMMARY**

DESCRIPTION OF THE ROUTE AND FUTURE MOTORWAY BASIC ELEMENTS....1

SOIL AND AGRICULTURAL LAND 6

WATER RESOURCES 12

FLORA 22

PROTECTED NATURAL AREAS....33

FAUNA AND HUNTING....33

LANDSCAPE 45

AIR QUALITY....46

SOCIO-ECONOMIC ANALYSIS 49

INFRASTRUCTURE SYSTEMS....51

CLIMATOLOGY CHARACTERISTICS....52

NOISE PROTECTION 53

MOTORWAY MANAGEMENT AND MONITORING SYSTEM....56

MEASURES CONNECTED TO TRANSPORTATION CONDITIONS BY ACCIDENTS 58

CONCLUSION 60

NON-TECHNICAL SUMMARY

Description of the route and future motorway basic elements

Planned route of the Corridor Vc motorway leads within LOT2 through municipalities Usora, Tešanj, Maglaj, Žepče, Zenica and Kakanj in Zenica Doboj canton. In Sarajevo canton it leads through municipalities Ilidža (from Vlakovo) and Hadžići (to Tarčin). In Srednja Bosna canton chosen route leads through Kiseljak municipality. Section Kakanj-Vlakovo (45km) is not the subject of this study, as it is currently under construction.

Motorway route is conditioned with area planning for this area. Area plans in Bosnia and Herzegovina were made after the adoption of Area Plan for Bosnia and Herzegovina for 1981-2000. Routes of European motorways (E 73, E 661, E 761 and E 762) were set within the Area plan of Bosnia and Herzegovina. A remark was made that special attention must be paid to the environment protection in municipality zonal plans and town planning documents along the route of trans-European motorway North-South, corresponding to E 73 road that which leads through valleys of rivers Neretva and Bosna.

Area plan of Bosnia and Herzegovina for 1981 – 2000 published in Official Gazette, no. 33/88, differs in the sense of motorway route positioning determined with Draft Plan from 1982. Hence the planned and allocated motorway routes in Zonal plans for municipalities Tešanj and Ilidža, and in Decision on spatial allocation for motorway corridor for municipality Kiseljak differ from adopted Area Plan B&H text, but correspond to planned motorway route or variant solution for motorways in Draft Plan.

Total length of the route within lot 2– Sarajevo south (Tarčin) is approx. 145km and is divided into 4 sectors as follows:

- Karuše-Donja Gračanica,
- Donja Gračanica-Kakanj,
- Kakanj-Vlakovo, and
- Vlakovo-Tarčin.

Sectors are divided into 8 sections;

Section 1. Karuše – Medakovo (chainage km 0+000 do 4+000)
Section 2. Medakovo - Ozimica (chainage km 4+000 do 24+876,440)
Section 3. Ozimica – Poprikuše (chainage km 24+876,440 do 38+617,434)
Section 4. Section Poprikuše – Nemila (chainage km 38+617,434 do 46+388,80)
Section 5. Nemila – Donja Gračanica (chainage km 46+388,80 do 58+434,599)
Section 6. Donja Gračanica – Drivuša (chainage km 58+434,599 do 66+959,592)
Section 7. Drivuša – Kakanj (chainage km 66+959,59 do 82+595,000)
Section 8. Blažuj – Tarčin[1] (chainage km 0+000 do 19+100)

Position of the route in relation to the settlements is shown at Illustration1.1.

[1] Within some analysis divided into sub-sections 8a Blažuj-Vlakovo and 8b Vlakovo-Tarčin.

Illustration 1.1: Position of the route in relation to the settlements

Struktura naselja u području uz izabranu trasu autoceste na Koridoru Vc - LOT2

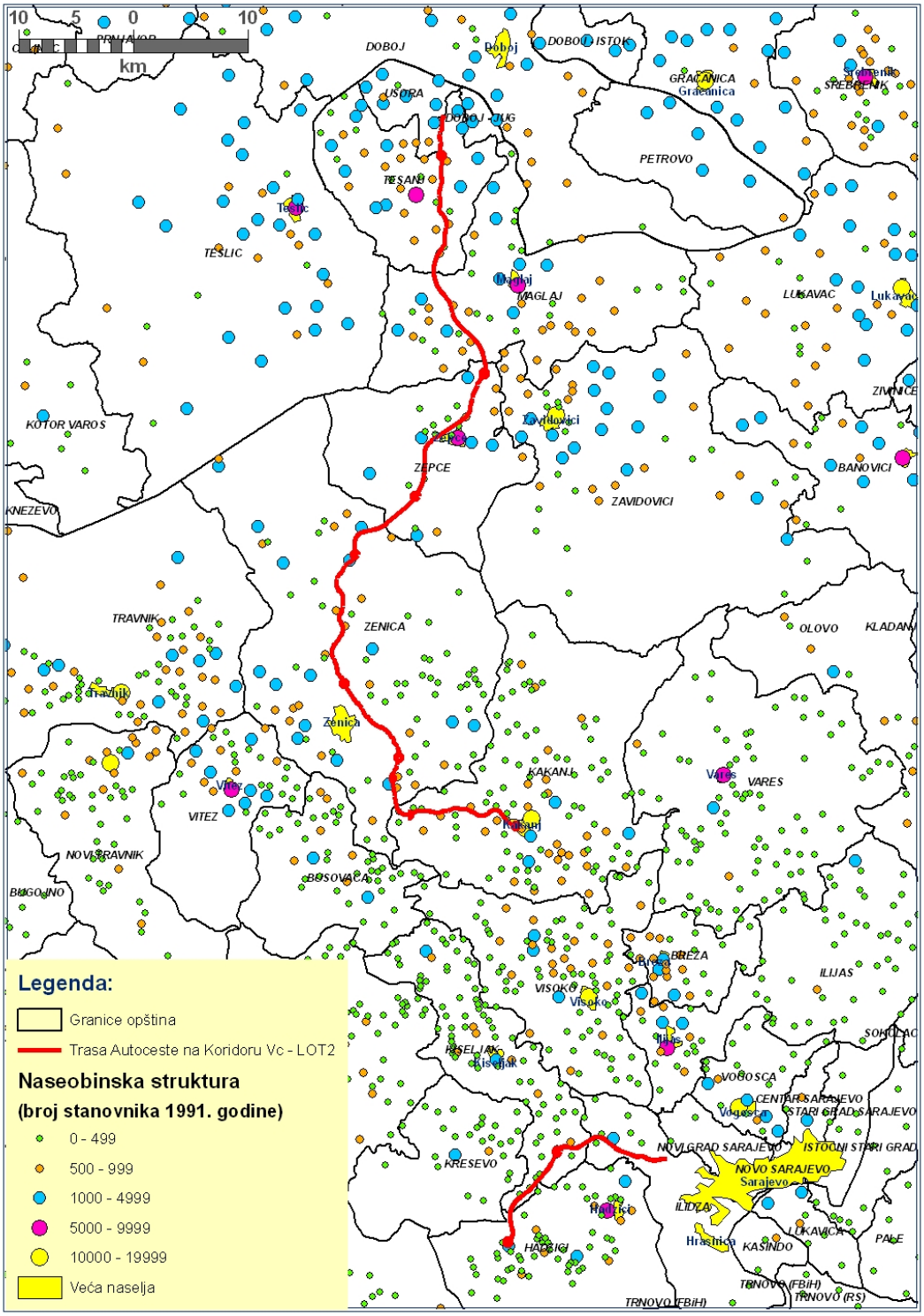

Table 1. shows main characteristics of the motorway sections within LOT 2.

Terrain of the motorway route in Lot2 Karuše – Sarajevo south (Tarčin) represents rugged land from the aspect of relief-morphological characteristics. Interchange Karuše is designed at the crossroad with road M4 Doboj – Teslić. City of Teslić and other surrounding settlements are connected to motorway through this interchange. Part of road between Rudanka and Karuše contains 32,8% of bridges and tunnels out of total section length with average elevation of 165m above sea level.

Further, runs along River Tešanjka and Trebačka to the notch Crni vrh where tunnel L=2.605m is planned. On this part of motorway maximum gradient equals i_{max}=1,5% for the length of 1.401m while inside tunnel gradient equals i_t=3% and is one-sided. Gradient of alignment is constant. Maximum curve radius is R_{min}=800m.

From Crni vrh notch or km14+181 route follows Stupanjska river or Stupanjski potok with constant inclination until km 23+641 of i_{max}= 3,5% in a length of 1.875m. Minimum radius of a horizontal curve is R_{min}=1.700m. From km23+641 to km27+200 alignment has a gradient i_{max}= 3,5% in a length of a 2.038m and with R_{min}=950m. After this, motorway enters vary narrow valley of River Bosna and runs along it to Kakanj.

From km27+200 to Donja Gračanica km58+037, motorway is positioned on very unfavorable terrain, which requires construction of numerous structures and tunnels (8 tunnels longer than 500m and two bridges, l=432m and 465m). Due to better adjustment to terrain, the alignment is not continuous. Maximum gradient is 3,96%/1.360m, with minimum radius R_{min}= 650m of a vertical curve.

Continuing from Donja Gračanica, route passes around city Zenica, elevating to maximum of 464m above sea level, reaching point 150m higher than the city. Maximum gradient of alignment is i_{max}=4%/3.602m, with R_{min}=1.000m and R_{vmin}=22.500m. Because of population density and unfavorable topographic conditions extensive roadbed insurances on this part of route will be required.

Part of route from Drivuša to Kakanj will be made by enlargement and transformation of road M17 into a motorway in total length except for tunnel Vijenac L=2.964m in Lašva valley. Alignment is very favorable i_{max}=2% and R_{vmin}=50.000m. This part of the route with exceptional curve radius of 450-550m (four times) is kept as original built M17. Enlargement of M17 road is two sided: emergency stopping lane is attached to a left side, while complete right half of motorway is attached to a right side of the existing road.

As shown in a Figure 1.1, part of route from Rudanka to Kakanj is characterized by numerous bridges and tunnels in particular the parts between interchanges Ozimica – Poprikuše (59,74%), and Nemila-Gračanica (58,86%), and part of route between two Lašvanske half-interchanges (87,19%).

At sector Vlakovo - Tarčin, route must be connected to a Sarajevo bypass at interchange to Blažuj in Vlakovo. This was taken into consideration when making preliminary solution, although the designed route start was moved closer towards Tarčin for 2,2km. Preliminary design should consider missing part of route as well as interchange Vlakovo. In this sector as well, route is placed on a terrain with very unfavorable topographic conditions resulting in high percentage of bridges and tunnels in total length of route: between interchanges Vlakovo-Lepenica 39,87%, and between Lepenica-Tarčin 58,35%.

Table 1. Technical parameters of proposed route sections in sector Karuše-Sarajevo south (Tarčin)

Section No.	Sector (with sections between interchanges)	Length (from km - to km)	Route length (km)	Average alignment gradient (%)	Curve Sa/L (°/km)	Σ Bridges (km)	Σ Tunnels (km)	R_{min}	Average alignment elevation	Percentage of bridges and tunnels in total route length (%)
1	Karuše-Medakovo	63+112-63+963 0+000-3+527	4,378	0,45	20,28	0,743	0,245	750	172	22,57
2	Medakovo-Ozimica	3+527-24+388	20,861	1,82	25,88	1,916	2,605	800	270	21,67
3	Ozimica-Poprikuše	24+388-37+400	13,012	1,59	27,81	2,268	5,505	950	276	59,74
4	Poprikuše-Nemila	37+400-45+428	8,028	0,42	28,76	0,900	4,580	900	283	68,26
5	Nemila-Donja Gračanica	45+428-58+037	12,609	1,53	43,89	2,532	4,890	750	357	58,86
Sector Karuše-Donja Gračanica		**63+112-63+963 0+000-58+037**	**58,888**			**8,359**	**17,825**			**44,46**
6	Donja Gračanica-Drivuša	58+037-66+385	8,348	2,66	30,09	1,75	2,050	1.100	420	45,52
7	Drivuša-Lašva 2	66+385-68+356	1,971	0,45	43,94	0,000	0,000	730	336	0,00
8	Lašva 2-Lašva 1	68+365-72+237	3,881	1,43	21,22	0,420	2,964	900	368	87,19
9	Lašva 1-Kakanj[2]	72+237-81+608	9,371	0,25	44,82	0,390	0,000	450	371	4,16
Sector Donja Gračanica-Kakanj		**58+037-81+608**	**23,571**			**2,560**	**5,014**			**32,13**
10	Vlakovo-Lepenica[3]	0+000-7+360	7,360	2,00	27,24	0,739	2,195	750	571	39,86
11	Lepenica-Tarčin	7+360-16+897	9,537	1,44	16,28	1,765	3,800	1.000	599	58,35
Sector Vlakovo-Tarčin		**0+000-16+897**	**16,897**			**2,504**	**5,995**			**50,30**

Source: Pre-Feasibility Study – LOT 5

[2] The end of sector is 985,5m away from interchange Kakanj
[3] Start of sector is 2,2km away from interchange Vlakovo

Basic technical data:

- Designing standards: TEM standards.
- Motorway is designed with 2x2 traffic lanes in a cross section, each 3,75m wide; 2x1 emergency stopping lane 2,50m wide; and shoulders 2,00m wide.
- Curve and height parameters depend on terrain configuration with extreme values according to TEM standards.

Nine interchanges at locations Medakovo, Ozimica, Poprikuše, Nemila, D.Gračanica, Perin Han, Janjići, Dolipolje, Lepenica are designed.

Five rest areas at locations Tugovići, Strupina, Dujmovići, Bilješevo and Lepenica are designed.

Two maintenance centers are also designed at locations „Crni vrh“ and Zenica south.

Methodology of making Environmental Impact Study

In accordance with laws in force in FB&H from 2003 and general practice, environmental analyses for more complex structures are made at two levels:

- Initial estimate of environmental impacts made by ministry in charge and on the basis of a documentation prepared for previous estimate, and
- Issuing of permit on impacts on environment by ministry in charge on the basis of Terms of Reference made by Ministry and Study on environmental impacts on the basis of the Terms of Reference.

Initial estimate of environmental impacts was completed in June/July 2005, on the basis of Documentation submitted to the Investor by designer on April 15, 2005. Although the purpose of Initial estimate was only:

- Monitoring of state of environment in the proposed corridor area,
- Identification of potential alterations of environment and potential loss of environmental qualities,
- Identification of those impacts, which must be avoided at all costs because of legal requirements or the preservation of prominent natural and cultural heritage,

Analyses of alternate motorway routes, as a basis for public debate and Ministry expertise were done in a scope of this activity. Consequently, two routes which satisfied requirements have been selected:

- Areas where route cannot be laid are avoided (prohibited areas, occupied areas, areas with particularly valuable content)
- Areas with valuable content were avoided as much as possible (for example – arable land), and
- Measures for impact decreasing on the chosen route were identified.

By this:

- Analyses were made within the scope of Initial estimate documentation are:
  - Impact the route might have to the surrounding
- Analyses that are now being finalized, within the Study on environmental impacts are:
  - Regarding motorway construction (construction-site organization, mechanization organization, impacts from mechanization, manipulation with construction material, borrowing and disposal area...),
  - Regarding traffic (prevention of noise, air and water pollution) and

- Regarding management and motorway maintenance (impact monitoring, cleaning of water purification filters).

Documentation for Initial estimate of environmental impacts and Study of environmental impacts were done simultaneously by three groups of experts:

- Ecologists (experts for water and air, soil, bio-diversity, cultural heritage, landscaping),
- Area and economic growth planners, and
- Designers (including geologists, seismologists and hydrologists)

Each of theses expert groups analyzed properties of the wider corridor area in relation to their subject of expertise, and pinpointed sensitivities for the area considering construction and exploitation of the motorway (whether their expertise strictly forbids construction of motorway at micro location in question, whether the construction can be conducted as final alternative when there is no other solution, and whether it is acceptable with certain restrictions or whether it can be conducted without restrictions). Each expert group made their map of restrictions concerning space consumption, and each request was analyzed by experts from all three groups.
This knowledge was the basis for Initial estimate of environmental impacts on the surrounding. At later stage, when the opinions from the Ministry and citizens were collected at public debates it represented basis for Study of Environmental Impact. The difference of making Study of environmental impacts from activities related to collecting documentation for Initial estimate where motorway route was chosen and where conflicts in space were avoided or minimized was such that at this stage all necessary measures were undertaken in order to really achieve avoidance and minimization of impacts.

Soil and agricultural land

Participation of some soil types in Motorway Corridor Vc for LOT-2 in zone of 500 m is given in hectares and percentages:

- Lithosols	21,7 ha	0,4 %
- Calcomelanosol	67,6 ha	1,4 %
- Rendzinas	40,6 ha	8,3 %
- Rankers	79,1 ha	1,6 %
- Vertisols	111,3 ha	2,3 %
- Calcocambisols	25,7 ha	0,5 %
- Eutric Cambisols	1.384,7 ha	28,5 %
- Dystric Cambisols	1.213,1 ha	24,9 %
- Luvisols	465,4 ha	9,6 %
- Pseudogley	163,5 ha	3,4 %
- Fluvisols	928,6 ha	19,1 %
Total	4.867,1 ha	100,0 %

At complete route, Eutric Cambisol is present the most with 1.384,70 ha or 28,50 %, and the smallest quantity belongs to Litosol with 21,7 ha or 0,4 %.

Land types represented within the corridor of the Vc motorway alignment for LOT-2 in the zone of 500 m, are shown in hectares and in percentages:

- Agricultural land	1.968,7 ha	39,1 %
- Forest land	1.134,1 ha	22,5 %

- Developed land	488,5 ha	9,7 %
- Water courses	185,0 ha	3,7 %
- Other (tunnels)	1.252,5 ha	25,0 %
Total	5.027,7 ha	100,0 %

For the whole motorway alignment the prevailing type of land is agricultural land with 1.968,7 ha or 39,1 %, while water courses are represented only with 185,0 ha or 3,7 %.

Agricultural soils represented with regards to the utilization categories within the corridor of the Vc motorway alignment for LOT-2 in the zone of 500 m, are shown in hectares and in percentages:

- Arable soil	1.625,0 ha	82,6 %
- Orchards	61,7 ha	3,1 %
- Meadows	232,7 ha	11,8 %
- Pastures	35,8 ha	1,8 %
- Barren land	13,5 ha	0,7 %
Total	1.968,7 ha	100,0 %

For the whole motorway alignment the prevailing type of agricultural soil is arable soil with 1.625,0 ha or 82,6 %, while barren land is represented with 13,5 ha or 0,7 %.

Soils with different agricultural quality classes represented within the corridor of the Vc motorway alignment for LOT-2 in the zone of 500 m, are shown in hectares and in percentages:

- I	2,1 ha	0,1 %
- II	590,8 ha	30,0 %
- III	482,7 ha	24,5 %
- IVa	79,8 ha	4,1 %
- IVb	474,7 ha	24,1 %
- V	165,1 ha	8,4 %
- VI	126,2 ha	6,4 %
- VII	26,5 ha	1,3 %
- VIII	20,7 ha	1,1 %
Total	1.968,7 ha	100,0 %

For the whole motorway alignment the prevailing type of agricultural land represented the most is the soil with agricultural quality class II with 590,8 ha or 30,0 %, while the soil with agricultural quality class I is represented with 2,1 ha or 0,1 %.

Arable soil with different quality classes represented within the corridor of the Vc motorway alignment for LOT-2 in the zone of 50 m, are shown in hectares and in percentages:

- I	0,1 ha	0,0 %
- II	89,0 ha	39,8 %
- III	48,3 ha	21,6 %
- IVa	6,1 ha	2,8 %
- IVb	41,2 ha	18,4 %
- V	23,0 ha	10,3 %
- VI	11,7 ha	5,2 %

- VII	3,3 ha	1,5 %
- VIII	0,7 ha	0,4 %
Total	223,6 ha	100,0 %

For the whole motorway alignment the prevailing type of arable soil is Class II quality arable soil with 89,0 ha or 39,8 %, while the arable soil of Class I quality is represented with 0,1 ha or 0,04%.

Agro-zones of agricultural land represented within the corridor of the Vc motorway alignment for LOT-2 in the zone of 500 m, are shown in hectares and in percentages:

- First agro-zone	1.630,0 ha	82,8 %
- Second agro-zone	291,5 ha	14,8 %
- Third agro-zone	47,1 ha	2,4 %
Total	1.968,7 ha	100,0 %

For the whole motorway alignment the prevailing agro-zone is the First agro-zone with 1.632,5 ha or 82,8 %, while the Third agro-zone is represented with 47,1 ha or 2,4 %.

Impacts on soils and agricultural land

Impacts caused by construction of the motorway have been studied with regards to two aspects:

- The construction phase (direct impacts)
- The operational phase (indirect impacts)

During the construction phase there will be physical destruction of soils, i.e. permanent loss of soils, degradation of soils (erosion, losses of water courses, compaction and structure damaging), temporary occupation of areas (waste areas, construction sites, warehouses, quarries and similar), contamination of soil (oil, lubricants and fuel spillage), prevention of access to the agricultural land lots.

Permanent loss of soils: The construction of the motorway will result in physical destruction of soil due to construction of the motorway body itself as well as accompanying motorway services within the motorway corridor. These losses refer to construction of motorway lanes and central and side reserves, interchanges and toll collection facilities, shoulders and embankments, drainage structures and water treatment facilities, drainage culverts and channels, rest areas, parking lots, petrol stations, hotels, restaurants and tourist areas, prevention and safety facilities, maintenance and other necessary facilities.

Soil degradation: Utilization of access roads and marking of the alignment for construction of the motorway will result in degradation of soil such as erosion caused by removal of vegetation and by cuttings, and in significant effects with respect to groundwater flows due to collecting of drain waters, damaging of soil structure and compaction of soil due to passing of heavy machinery over the arable land.

Temporary occupation of certain areas: Some of the areas are going to be occupied temporarily for construction of various structures, utilization of soil and construction materials. This is going to reflect in construction of site facilities such as temporary residential area, parking lots, warehouses and storage areas and similar, as well as establishing of waste areas for depositing of removed soil material and quarries for obtaining of construction material for embankments.

Soil pollution: During construction of the motorway while using the construction machines and various means for transportation of construction materials, as well as machines for installation of such materials there is a possibility of soil pollution due to spilling of oil, lubricants and fuel. The consequence of such spilling is contamination of soil by organic pollutants (light and heavy fractions of hydrocarbons) and heavy metals (lead (Pb), zinc (Zn) and cadmium (Cd)).

Prevention of free access to the lots of arable land: In certain phases of construction some of the access roads to the arable land are going to be cut off which will prevent their normal usage. As a consequence some of the farmers may be faced with increased transportation costs of their products or with impossibility to apply adequate agro-technical measures in their fields. This primarily happens during construction of the alignment, i.e. by cutting of slopes and building of embankments, regulation of river beds or smaller water courses, construction of tunnels, bridges and viaducts as well as during construction of temporary structures and facilities.

During the phase of the motorway operation there will be processes of contamination and degradation of soils, crops and vegetation.

Soil contamination: During the phase of motorway operation due to participation of increased number of vehicles and their increased speeds, the soil will become more contaminated due to exhaust gases, wearing of tires and road maintenance activities. The consequence is pollution of soil by organic pollutants (light and heavy hydrocarbons), heavy metals (lead, zinc and cadmium) as well as by sodium chloride (used in winter period to prevent ice on the pavement). The process of soil pollution during the motorway operational phase is going to be more intensive and will last for a longer time period, which can lead to contamination of vegetation and crops. It will especially affect agricultural products such as fruits and vegetables (salad, spinach, onions and similar).

Degradation of soil and crops: Incident situations, such as traffic accidents leading to turning over or skidding of the vehicles into the surrounding agricultural or forest land, especially when heavy vehicles or trucks with trailers are involved, can lead to compaction or damaging of soil structure, damaging or total destruction of crops, damaging of infrastructure (safety barriers, fencing, poles, railings, etc.) as well as demolishing of equipment, irrigation and drainage systems (pipes, channels and similar).

Mitigation measures for soil and agricultural land impacts

System of measures for mitigation of negative impacts on soil and agricultural land covers prevention measures, mitigation measures and rehabilitation measures.

Prevention measures: The main objective of the prevention measures is to act on time in order to prevent negative effects on soil and agricultural land, and therefore on agricultural production. These measures consist of prohibition to use fuels that contain lead, obligatory usage of catalysers in the vehicles, reduced speed at critical points and in areas of intensive agricultural production (First Agro-zone), prohibition of agricultural products cultivation in the vicinity of the motorway corridor especially those products that in their edible part can accumulate harmful and hazardous substances (such as salad, spinach, onions, etc.), usage of agricultural products cultivation under controlled conditions in the areas close to the motorway alignment (production of flowers and decorative plants in the greenhouses), production of industrial plants and field crops (potatoes, cereals and food grains) in open areas, as well as fruits and vegetables at a greater distance from the motorway. All these measures should be introduced on the basis of suitable legal regulations and fully in compliance with the principles of sustainable development and international standards.

Mitigation measures: Mitigation measures refer to undertaking of activities in the motorway construction phase with the aim to prevent adverse effects on soil and plants, i.e. on agricultural production, which are manifested through removal and storing of fertile soil, securing of passages and access to the farms, remedy of the degraded soil, decontamination of contaminated soil and extensive planting of bushes and trees along the embankments.

Removal and storage of fertile soil: Having in mind the fact that there are no absolute measures for protection of the soil and that occupation of valuable agricultural quality class soils (First Agro zone) could not be avoided, it is necessary to undertake removal and storage of fertile soil. Arable soil with different quality classes represented within the corridor of the Vc motorway alignment for LOT-2 in the strip of 50 m, are as follows:

- II	890.000 m^2 x 0,45 m = 400.500 m^3
- III	483.000 m^2 x 0,35 m = 169.050 m^3
- IVa	61.000 m^2 x 0,30 m = 18.300 m^3
- IVb	412.000 m^2 x 0,25 m = 103.000 m^3
Total	= 690.850 m^3

Therefore for the whole motorway alignment it is necessary to remove 690.850 m^3 of fertile soil.

Securing of passages and access to the farms: In the phase of motorway construction when the contractors start with execution of the works or in the case when, due to regulation of water courses, access to the farms is prevented, it is recommended to undertake necessary measures to secure and provide access to such farms in order to avoid disruption of their utilization. Such measures cover construction of access roads, construction of bridges and passages. These measures will be undertaken as necessary either individually or in combination with other measures.

Remedy of degraded soil: During construction of the motorway there will be a need to rehabilitate soils due to appearance of erosion processes or cutting of water bearing strata in the areas where the site structures had to be built (such as site residential compounds, parking lots, warehouses and storage areas and similar), in the storage areas for depositing of removed rich soil and opened borrow pits for the filling material. For this purpose it is necessary to prepare the soil remedy and re-cultivation programme fully in compliance with valid legal regulations and the Law on agricultural soil (Official Gazette of FBH 2/98).

Soil decontamination: In a situation when it comes to spilling or leaking of fuel, lubricants or similar hazardous liquids it is necessary to undertake adequate soil decontamination measures. Such measures should include sprinkling of the spillage with sawdust followed by burning of collected sawdust. Final measure is removal and depositing of contaminated soil.

Extensive planting of bushes and trees along the embankments: In order to prevent contamination of highly valuable agricultural soil (Class I and Class II quality) it is necessary to build a vegetation protective belt up to 2,5 to 3,0 meters high. With regards to the quality classes of agricultural soil for the whole motorway alignment it is necessary to build 21.720 meters of vegetation belt on the right side and 20.500 m on the left side of the motorway. In total it is 42.220 meters of the protective vegetation belt.

Rehabilitation measures: During operation of the motorway it is necessary to undertake adequate rehabilitation measures due to degradation of soil, adverse effects on agricultural and food production and damaging of infrastructure (contamination and accidents) such as:

- Establishing of monitoring system,
- Undertaking of soil decontamination measures,

Establishing of monitoring system: In order to follow adverse effects of the motorway on agricultural soil it is necessary to establish a system which will monitor concentrations of heavy metals, organic pollutants and salts, and on the basis of the readings propose, adequate rehabilitation measures.

Soil decontamination measures: During the motorway operational phase, the process of soil contamination is going to be more pronounced. This process will be noticed more in the vicinity of the motorway at a distance from 0 to 200 meters right and left of the road. Soil contamination can be mitigated by eliminating the adverse effects of the pollutant in the soil. Measures for rehabilitation of contaminated soils can be divided into technical, chemical and phito-melioration measures.

System for monitoring of the soil condition

Environment Protection Law of the Federation of Bosnia and Herzegovina stipulates the procedure for assessment of the environmental impacts as well as for undertaking of certain activities in the environment which are described in Articles 3. and 4. of the Regulations for construction of the plants for which an environmental impacts assessment is obligatory ("Official Gazette of the Federation of Bosnia and Herzegovina", No. 19/04). Due to the fact that the Corridor Vc Project covers construction of the motorway, this Project is on the list of the projects for which undertaking of an Environmental Impacts Assessment Study is obligatory. The main objective of this study is to establish the extent of soil degradation and contamination, selection of possible mitigation or protection measures, evaluation of alternative methods and designs for ultimate protection measures and assistance in development of the environment management plan.

Programme of soil monitoring activities

Zero case: The subject of this monitoring is the soil located along approx. 500 metres wide strip of the adopted motorway alignment of the LOT 2 section, in the total length of approx. 102 km of which the agricultural soil is along approx. 49 km, forests along 13 km and the rest of the alignment belong to the tunnels and bridges. 32 localities have been preliminary identified during analysis of the adopted Corridor Vc Motorway alignment where the soil samples have been taken for the purpose of establishing of Zero case quality.

Monitoring of soil during the construction phase: During the construction phase some problems with degradation and contamination of the soil by organic pollutants and heavy metals could be expected. In order to monitor such degradation it is necessary to follow the situation and changes such as:

- Erosion of the soil due to removal of vegetation and cutting of slopes;
- Appearance of surface waters due to drainage and catchments waters,
- Construction of site facilities (settlements, parking areas, warehouses and storage areas and similar),
- Putting up of areas for depositing of removed rich soil,
- Utilization of filling material, borrow pits, etc.

Monitoring of soil contamination: Usage of the construction machines and heavy trucks for transportation of construction materials as well as installation of equipment and materials may

cause contamination of the soil due to spillage of oil, lubricants and fuel which is expressed through:

- Contamination by organic pollutants (light and heavy fractions of hydrocarbons).

All the above mentioned damages have to be evaluated and necessary preventive measures and rehabilitation processes determined through development of suitable programmes and projects.

Monitoring of the soil during the operational phase: Contamination of the soil is very frequent along the heavily trafficked roads. Metals such as lead, zinc, cadmium and chrome remain in the soil for many years. Pollutants from the soil along the motorways penetrate into the food chain of the plants and animals, while due to erosion of the soil they get into other eco-systems. Industrial salts used for salting of the roads during the winter period get into the soil and degrade fertility of the same. Consequences of the traffic and the pollutants' impacts have cumulative effects on the soil as well as on many other aspects of the life in the environment. Due to all the facts mentioned above it is necessary to be familiar with the situation and to monitor all changes along the motorway alignment in order to avoid accident situations or any improvisations with regards to evaluation and assessment of impacts of the future motorway on the environment.

Water resources

A dense network of water flows exists in the motorway zone, the most significant of which is the River Bosna and its small and large tributaries (Tešanjka, Liješnica, Strupinska River, Kardaglijska River, Ozimica, Trebačka River, Gračanička River, Nemilska River, Lepenica etc.). Besides this dense network of surface waters, there are significant resources of underground waters, most of which have not been sufficiently explored.

During preparation of the Environment Impact Study for LOT 2, the Consultants for the water resources aspect contacted the representatives of all eight municipalities, through which area the concerned section passes, as well as the water utility companies in those municipalities. With their assistance, the detailed data on sources used in the public water supply system of cities and suburban settlements have been collected and presented in the Study, as well as data on the sources of local nature. In some cases, municipalities and utility companies did not have data on local sources, so that they had been collected in local communities.
The significant information in relation with the sources for water supply, as well as the assistance in planning of water resources monitoring along the LOT 2 for motorway construction and exploitation phases were obtained from Public Company for Watershed Areas of Sava River catchments in Sarajevo. For consideration and overall view of water resources aspect along the route, and for the needs of Study preparation, all available sources have also been used, which list is given in the reference list of the used literature and documentation at the end of this Study.

The scope of the water resources aspect consideration in the Study was 1 km to the left and to the right from the adopted motorway route for which the Preliminary Design is being prepared. In final lay down of the route, the designer took into account that the sources of the public water supply system of the cities and settlements along the section of LOT 2, as well as their accessory water protection zone are avoided. The water source Klopče, located in the public water supply system of Zenica City, is the only source located in the area of the scope of our consideration. This source is

located in section 6: Donja Gračanica – Drivuša (chainage km 58+434.599 to 66+959.592), i.e. between the chainages km 60+000 - 62+000.

In the area of the consideration scope, there area a large number of local sources not included in the public water supply system of the municipalities on which territories they are located.

When planning the route, special attention was paid to exclude sources of public water supplies for the towns and settlements along the section LOT2 and their water protection zones, from the catchment's area of the motorway route (1 km on the left and right from the approved route).

An exception is the Klopče source, a part of the public water supply system of Zenica town, situated in the considered catchment's area of the motorway route. However, a large number of local sources have been left in the considered catchment's area; these sources are not included in the system of public water supply of the municipalities where they are located. These local sources are used for the water supply of the population in the settlements through which the motorway passes or the settlements in the vicinity of the motorway.

On the basis of the analysis of hydro-geological features of the corridor, the Study established 33 sensitive water-bearing areas which are significant resources of good-quality drinking water for meeting the increasing needs. Also, as far as construction and operation are concerned, the Study defines that the banks of the water flows along which the route is planned and which intersect the motorway, are also considered to be sensitive areas, including the surface springs in and out of the water supply system.

One of the difficulties which occurred in the stage of developing of this Study was lack of a detailed hydro-geological map of the more immediate area around the motorway produced on the basis of research works. Taking into account specific conditions at the location and available data, the potential negative impact of the construction and operation of the motorway on surface and underground waters was assessed, and the relevant preventive measures/ minimizing of the negative impact was proposed. In many cases, and within the higher stages of project design, there was a lack of data, and a need to carry out detailed research of some of the water flows in order to establish potential negative impact of the motorway and vice versa.

In principle, the facilities for the treatment of waste waters from the motorway can be located in the areas that are defined as sensitive in the Study, but before the final selection of the location for the facilities, a detailed hydro-geological background of the more immediate area around the motorway in scale 1:5,000 should be consulted. It is necessary to avoid locating the facilities in the aquifer areas in which high water levels of underground waters were established in order to prevent disturbance of the hydraulic regime of underground waters, disturbance of feeding the groundwater etc.

Having in mind the above mentioned, it is necessary to check the anticipated impacts on the waters on the basis of the data that will be available upon the completion of research works, that is hydro-geological maps and length-wise sections of the more immediate area of the motorway in a detailed scale of (1:5,000).

Due to the fact that *the sources which are located within the public water supply system* of the towns Zenica, Žepče, Kakanj, Maglaj and Kiseljak are significantly distant from the motorway route, *no negative impacts are expected to occur* during the construction and operation of the motorway if proposed preventive measures are respected.

During the construction and operation stage, *the local sources of drinking water (sources in villages)* will be most exposed to harmful impacts. This negative impact is estimated as *significant* and the relevant preventive measures/measures for minimization of the impact have been proposed.

Significant negative impacts on the regime and quality of water are possible in all the places where the route is close to permanent or temporary underground water; the locations of the sources have been established through the analysis of hydro-geological structure of ground in the motorway catchment's area.

Also, significant negative impacts are possible in all places where the planned motorway and water flow intersect the motorway, including the areas where the route is situated along the banks of water flow, in the stages of construction and operation. Sensitive areas such as water-bearing areas also may be significantly endangered in the stages of construction and operation.

All expected adverse effects on water resources (underground and surface) in the phase of construction and exploitation could be avoided or reduced with the proposed prevention and minimization measures.

Considering that the motorway causes many changes on water manifestations along the route, which in great extent depend on the way of construction and exploitation. In accordance with that, and taking into consideration the Best Environmental Practices, the prevention measures i.e., measures of minimization of negative impacts have been proposed. The certain impacts on water can be avoided in the planning phase so in that sense, the prevention measures recommend the preparation of appropriate project solutions of external and internal drainage, planning of the bridge constructions with the condition that the bridge openings insures the flows of high waters of the certain phenomena rank and of the height differences defined in the water management conditions issued by the relevant ministries of the water management, designing of horticulture protective zone and planning of the vertical buffer fences along the motorway on the sensitive-marked locations from the aspect of water resources.

All characteristic places of the motorway passage over the watercourse along the LOT 2 per sections are given in the Table 2 that follows. Also, the expected impacts on the surface waters are presented, as well as the planned prevention and minimization measures for the harmful impacts in the construction phase.

Table 2. Characteristic places of the motorway passage over the watercourse along the LOT 2 per sections

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Section 1. Karuše – Medakovo Km 0+000 – 4+000			Pollution of the surface waters due to: ➢ Carrying out the construction works (mining, deep excavations, destroying and removal of the natural cover layer, concrete-work, reinforcing and similar). ➢ Accidental spillages or accidental pouring out the oil and oil derivates, disposal of the motor oil or similar waste. ➢ Usage of the inappropriate materials for construction ➢ Turbid or in other way polluted surface water can be drained in the coastal underground aquifers and pollute them. ➢ Uncontrolled drainage of the sanitary waters and polluted rainwater at the construction sites. Change of the surface water regime (quantity) due to uncontrolled disposal of excavated material into the watercourse riverbed. Possibility of occurrence of more massive disposing of the deposit, and by that also filling of the riverbed by reducing of its flow capacity what	➢ Special way of mining not to disturb the directions of the underground flows and of the recharge of surface watercourse. ➢ Good management practice on the construction site and with the traffic to avoid the watercourse pollution. ➢ Disposal not to be carried out in the riverbed and along the banks of the watercourses, or in the sanitary protection zones as well as in the zones defined as sensitive. In the case that these locations are located in the water asset and public water asset, it is necessary to apply for the water management authorization. ➢ All the material excavated, that will not be immediately used in the construction activities must be disposed on locations foreseen for that in accordance with the Design of the construction site organization (dumping sites of the material surplus) protected from the occurrence of the erosion, as well as outside of the defined sensitive zones. ➢ Keep the vegetation cover in the most possible extent, i.e. leave the buffer zones formed from the vegetation cover between the road and the watercourse. ➢ Use only clear material in the vicinity of the watercourse for the embankment, such as
Km 0 +750 to 4+250	Balnjača Luke Village Tešanjka River	River training length L= 3,605 m – riverbed trained with the reno mattresses		
Km 0+877.410	Bridge on Tešanjka River	Concrete bridge		
Km 1+763, 190	Bridge on Tešanjka River	Concrete bridge		
Km 3+121,860	Bridge on Tešanjka River	Concrete bridge		
Section 2. Medakovo – Ozimica Km 4+000 – 24+876,40				
Km 4+600 to 4+800	Obrenovac Trebačka River	River training length L= 200 m – riverbed trained with the reno mattresses		
Km 5+000 to 5+200	Obrenovac Trebačka River	River training length L= 180 m – riverbed trained with the reno mattresses		
Km 5+900 to 6+100	Bare Trebačka River	River training length L= 239 m – riverbed trained with the reno mattresses		
Km 6+900 to 7+100	Toplik Trebačka River	River training length L= 215 m – riverbed trained with the reno mattresses		
Km 6+917.00	Bridge on Trebačka River	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 8+500 to 8+800	Dolac Trebačka River	River training length L= 320 m – riverbed trained with the reno mattresses	can have the adverse consequences during the passage of the high floodwaters.	gravel, without the earth or other impurities. ➢ Protect the coastal areas sensitive to erosion by means of stabilization and with plants that prevent erosion. ➢ Prohibit any temporary or permanent disposal of the waste material on the surrounding soil, except on the locations foreseen for that by the Design of the construction site organization, as well as to ensure the watertight containers for waste. ➢ Supervise the processes of deposit formation, and organize the cleaning of the bottom and riverbed slopes from the surplus material. ➢ Carry out the frequent and controlled storage of the municipality and hazardous waste in the prescribed manner. ➢ Establish the continuous supervision during the works performance with the presence of specialist for environment protection. ➢ Sanction the offenders of the determined behavior rules in a disciplinary manner. ➢ To accept used waters from the construction site with the appropriate sewerage systems, collect it in the watertight reservoirs and treat it in a prescribed manner (either at the site, or in the remote location), and before discharge into the recipient or city sewerage. ➢ Inevitably set out the ecological toilets for the needs of the workers on the
Km 9+150 to 9+350	Luke Trebačka River	River training length L= 215 m – riverbed trained with the reno mattresses		
Km 10+150 to 12+820	Karadaglije Trebačka River	River training length 2890 m - riverbed trained with the reno mattresses		
Km 10+840	Čaglići Trebačka River	Concrete bridge		
Km 11+046	Čaglići Trebačka River	Concrete bridge		
Km 11+611	Zaimovići – Alispahići Trebačka River	Concrete bridge		
Km 12+748	Karadaglije Trebačka River	Concrete bridge		
Km 16+050	Mladoševica – Stupina Strupinski stream	Concrete bridge		
Km 16+730	Mladoševica – Stupina Strupinski stream	Concrete bridge		
Km 17+980 to 18+340	Galovac Strupinski stream	River training length L=373 m - riverbed trained with the reno mattresses		
Km 18+950 to 19+850	Galovac Strupinski stream	River training length L=940 m - riverbed trained with the reno mattresses		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 20+150 to 20+250	Ljubatovići Strupinski stream	River training length L=110 m - riverbed trained with the reno mattresses		locations of the construction site. ➢ Insure the areas with he watertight layer for placement and servicing of the construction mechanization, outside of the defined sensitive zones. ➢ Collect the oiled rainwater from the location of the construction site into he watertight reservoirs and treat them in the prescribed manner (either at the site or in the remote location), and before discharge into the recipient or the city sewerage. ➢ Prohibit the repairs of the construction machines, as well as the oil change in the defined sensitive zones. ➢ All construction areas and other impact zones during the construction is necessary to restore during the construction in accordance with the Plan of restoration, i.e. depending on the future usage of the area bring that in the original status. ➢ Ask for special water management conditions for locations of construction basis, services, asphalt basis, borrow pits and other structures in the next designing phase. ➢ During construction in the sensitive zones, set out the notices (plates) for workers on the construction site with the warning of the construction works in these zones. ➢ In the case of accidents, spillage of the fuel
Km 21+150 to 21+400	Ljubatovići Strupinski stream	River training length L=230 m - riverbed trained with the reno mattresses		
Km 21+650 – 22+000	Bečkića selišće Strupinski stream	River training length L=390 m - riverbed trained with the reno mattresses		
Km 22+650 to 22+980	Bečkića selišće Strupinski stream	River training length L=350 m - riverbed trained with the reno mattresses		
Km 23+269,90	Ozimica Liješnica River	Concrete bridge		
Km 23+668	Bečkića selišće - Ozimica Strupinski stream	River training length L=348 m - Ozimička petlja and L= 60m Goliješka petlja - riverbed trained with the reno mattresses Concrete bridge		
Section 3 Ozimica – Poprikuše Km 24+876,40 – 37+740				
Km 28+026,440	Tatarbudžak Stream 50	Concrete bridge		
Km 28+676,440	Tatarbudžak Stream 51	Concrete bridge		
Km 28+876,440	Tatarbudžak Stream 52	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 29+626,440	Vašarište – Bljuva Bljuva Stream	Concrete bridge		or lubricants into the environment, the urgent intervention is necessary in accordance with the Plan for fast interventions in the case of accidents.
Km 32+026,440	Papratnica Ljubna River	Concrete bridge		
Km 32+526,440	Papratnica Papratnica River	Concrete bridge		
Section 4 Poprikuše – Nemila Km 37+740 – 46+388,80				
Km 41+690	Kahrimani Sarevački stream	Concrete bridge		
Km 42+970	Topčić field Stream 63	Concrete bridge		
Km 43+170	Topčić field Kočin stream	Concrete bridge		
Km 46+090	Orahovačko field Krivača River	Concrete bridge		
Section 5. Poprikuše – Nemila Km 46+388,80 – 58+434,60				
Km 46+500	Orahovačko field Stream 71	Concrete bridge		
Km 46+800	Nemila Repeljski stream	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 47+000	Nemila Selački stream	Concrete bridge		
Km 47+540	Nemila Stream 75	Concrete bridge		
Km 47+670	Nemila Stream 76	Concrete bridge		
Km 56+300	Vranduk Stream 80	Concrete bridge		
Km 56+650	Vranduk Jelovik Stream	Concrete bridge		
Km 57+860	Donja Gračanica Gračanička River	Concrete bridge		
Section 6. Donja Gračanica – Drivuša Km 58+434,60-66+941,10				
Km 58+537,350	Donja Gračanica Suha River	Concrete bridge		
Km 59+640	Zenica - Dobra voda	Concrete bridge		
Km 61+036	Zenica – Kopilo Babina River	Concrete bridge		
Km 64+540	Zenica – Perin Han Stijenčice Stream	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 65+580	Zenica – Perin Han Stream 87	Concrete bridge		
Km 65+690	Zenica – Perin Han Đulanova River	Concrete bridge		
Section 7. Drivuša - Kakanj Km 66+941,10 – 82+121,10				
Km 67+691 to 67+941	Drivuša Bosna River	River training length L= 250 m – riverbed trained with the reno mattresses		
Km 68+321,10	Janjići Prihodi Stream	Concrete bridge		
Km 75+537,30	Modrinje Repovačk i Stream			
Section 8. Blažuj – Tarčin Km 0+000 – 18+885,40				
Km 1+770	Vlakovo – crossing Kulićev Stream	Concrete bridge		
Km 4+050	Kobiljača – Rudnik Rakovica River	Concrete bridge		
Km 4+700 – 5+750	Rakovica Kremikov ac Stream	River training length L= 850 m – concrete riverbed		
Km 7+400	Azapovići Stream 109	Concrete bridge		
Km 9+300	Kuliješ Stream 113	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 10+720	Donji Bojaković i Stream 114	Viaduct		
Km 11+120	Solaković Stream 115	Concrete bridge		
Km 11+950	Zabrđe – Mokrine Mlinčići Stream	Viaduct		
Km 12+675	Zabrđe – Mokrine Stream 117	Concrete bridge		
Km 13+037.890	Zabrđe Tisovački Stream	Concrete bridge		
Km 18+330	Tarčin Mlavica Stream	Concrete bridge		
Km 18+300 to 18+500	Tarčin Bijela River	River training length L= 230 m – riverbed trained with the reno mattresses		
Km 18+512	Tarčin Korča River	Concrete bridge		

Implementation of the foreseen measures of prevention and minimization of the impacts in the phase of motorway exploitation (maintenance of the constructed structures for drainage and treatment of wastewaters from the roads, and winter maintenance of the road according to the operational plans) the expected adverse impacts on the quality of the ground and surface waters can be avoided.

With the aim of consideration and valorization of changes in the environment as a result of construction and exploitation phase, i.e. considering the effects of proposed measures of prevention/minimization, as well as introduction of necessary improvements and corrections, the plan for monitoring the surface and ground water manifestations both in the motorway construction period and also the motorway exploitation period has been proposed.

The pollution in the case of accidental situations especially when heavy vehicles participate, which transport a hazardous loads (the traffic accidents, breakdowns) and because of the reason that it is not possible to foresee the time and space presents a special problem during the construction and exploitation phase. In that sense, it is necessary to apply all available measures for reduction of probability of occurrence of these accidental situations. In the case that those situations, however, occur during the construction and exploitation phase, the Study foresees the preparation of plans for fast interventions and the organization and equipment of adequate intervention services in order to ensure the restoration of damages caused by accidents in as short period as possible, and also in order to prevent the occurrence of accidents of larger scale.

All anticipated negative impacts on the mentioned water flows in the construction and operation stage may be avoided or mitigated by the proposed preventive/minimisation measures. Having in mind that the motorway will cause a number of changes in water flows along the route, which mostly depend on the manner of construction and operation, the measures for prevention or minimisation of damage have been proposed taking into consideration the best environmental practices.

Some impacts on water flows can be avoided in the design stage; having that in mind, the preventive measures include a recommendation for developing design solutions for external and internal drainage, design of horticultural protective areas, and design of fences along the motorway in the areas defined as vulnerable and sensitive.

Negative impacts on the quality of underground and surface waters can be avoided by an appropriate organisation of construction site and application of proposed preventive measures in the stage of construction, and through maintenance of the facilities for waste water filtering in the operation stage.

In order to comprehend and evaluate the changes in the environment during the construction and operation stage, that is effects of the proposed preventive/minimization measures, and to introduce necessary improvements and corrections, the monitoring plan has been proposed for surface and underground waters both in construction and operation stages.

A special problem regarding construction and operation is pollution in case of accidents, especially those with heavy vehicles which transport dangerous loads (traffic accidents, breakdowns) and unpredicted problems with weather. In such situations in construction or operation stage, the Study anticipates development of plans for urgent interventions including organizing and equipping the relevant emergency service in order to provide in the shortest period possible fixing of the damage caused by the accidents and prevention of further damage.

Flora

During the Study preparation, the Consultants for the flora aspect contacted the representatives of the forest offices in municipalities Tešanj, Žepče, Zenica, and Public Company ŠPD of the Zenica-Doboj Canton and Public Company „Sarajevo forests“ the stock company.

For the determination of significant vegetation units on the research region, the EUNIS classification of types of habitats has been used which represents the overall pan European system that stimulates the harmonization of the descriptions and collections of data from all parts of Europe using the criteria for identification of habitats. This classification includes all types of habitats, from natural to artificial, from land to fresh-water and marine-water.
The habitat type is for the needs of EUNIS classification of habitat types defined as: « plant and animal communities as a characterizing element of biotic environment, which together with abiotic factors act on the given scale». All factors, which have been involved in the definition, are being elaborated in the descriptive work shape of habitat classification. The database includes EUNIS habitats and Annex I habitats from EU Habitat directive. The Annex 1 of the Directive 92/43/EEC represents the list of « the types of natural habitats which are of interest for the community whose conservation requests the establishment of special zones for conservation».

On the section 1, there are the community of eco-systems of xerothermic forest of eastern hornbeam and Eastern white oak - Querco–Ostryetum carpinifoliae (EUNIS habitat code G1.7C1) and the community of eco-systems of white willow forest - Salicion albae (Habitat code 91A0).

On the section 2, there are community of eco-system of the xerothermic forest of eastern hornbeam and eastern white oak - Querco–Ostryetum carpinifoliae (EUNIS habitat code G1.7C1) and the community of eco-system of white willow forest - Salicion albae (Habitat code 91A0), the basophilic pine forests on the serpentines (Pinetum silvestris-nigrae serpentinicum)

On the section 3, there are the xerophilic oak forests on the serpentines of the chestnut oak forests with evergreen oak Erico-Quercetum petraea (K. ET L.) HT; heaths, the vegetation of rocks and rocky grounds, the vegetation of rocks, the community of white willow forest ecosystem Salicion albae (EUNIS Habitat code 91A0), the community of hygrophile forest and of alder brushwood eco-system (EUNIS Habitat code 91E08*).

On the section 4, there are the community of eco-system of the oak-hornbeam forests Querco-Carpinetum betuli (EUNIS Habitat code G1.A1A), the community of eco-system of white willow forest Salicion albae (EUNIS Habitat code 91A0), the community of hygrophile forest and alder brushwood eco-system (EUNIS Habitat code 91E08*).

On the section 5, there are communities of eco-systems oak-hornbeam forests Querco-Carpinetum betuli (EUNIS habitat code G1.A1A), of alder forests which differentiate on more communities and most prevalent are:
The forest of Frangulo alni- Alnetum glutinosae
The forest of continental region of Alnetum glutinosae montanum
The forest of crone and Carici elongatae-Alnetum glutinosae

The zone of the mezophile forests prospers most frequently on less steep slopes and significantly developed soils with respect to previous vegetation. This vegetation belongs to the form of foliage-deciduous forests of Fagetalia Bleč. et Lkšić 70 (the montane forests of beech).

On the section 6, there are the communities of eco-system of xerothermic forest of eastern hornbeam and eastern white oak - Querco–Ostryetum carpinifoliae (EUNIS habitat code G1.7C1) and the community of white willow forest eco-system Salicion albae (Habitat code 91A0).

On the section 7, there are the communities of the hornbeam-oak forests Querco- Carpinetum betuli (EUNIS Habitat code G1.A1A), community of eco-systems of xerothermic forests of the eastern hornbeam and eastern white oak Querco–Ostryetum carpinifoliae (EUNIS Habitat code

G1.7C1), community of thermophilic forests of chub and eastern oak Aceri obtusati-Ostryetum carpinifoliae (EUNIS Habitat code G1.7C3), the community of the eco-systems of hygrophile forests with common oak and common hornbeam Carpino betuli-Quercetum roboris (EUNIS Habitat code 91F0), the community of eco-system of white willow forest Salicion albae (EUNIS Habitat code 91A0), the community of eco-system with fern Pteridietum aquilini (EUNIS Habitat code E 5.3), the community of eco-system of the hygrophile forests and the alder brushwood (EUNIS Habitat code 91E08*), the community of eco-systems with mezophile meadows (EUNIS Habitat code 6510), the community of eco-systems of hygrophile meadows (EUNIS Habitat code 6410, 2330), and the eco-systems of the tertiary groups of eco-systems of the urban and rural regions.

On the section 8, there are the communities of the eco-systems – the oak and hornbeam forests Querco- Carpinetum betuli (EUNIS Habitat code G1.A1A), the community of the willow and poplar in the class Populetalia albae BR.-BL. 31, the groups of eco-systems the hydrophile forests and the shrubbery of alder (EUNIS Habitat code 91E08*).

The impacts on the flora are expected in all phases of the construction of highway: construction, maintenance and the exploatation of highway. The most important impact is the cutting off the forest vegetation and the potential erosion of the soil, in the construction phase, especially on the sections where the soil is shallow as it is the case with the serpentine complex in the region of Žepče, then the destruction of biological resources or eco-systems that is necessary to protect. The most important negative impact is the pollution because of the emission of engine oil and gases in environment and the waste dumping in natural eco-systems in the exploitation phase. The quantity of the wood biomass that is necessary to remove along the route on LOT 2 amounts to 4.664,5 m3 and on the total length of 7.915 m.

The planting can help in the supporting of a local flora and fauna in the zone of the future highway. It is possible to create the additional habitats with planting and to provide the migration routes for local types of animals and in the same time the erosion protection. The plant types planted on the edges of protection zone should be well resistant on the wind and help in the protection of erosion, especially on the regions of Žepče. The planting should be carried out with use of the native plant types, always when it is possible, because they will likely require less maintenance and to be useful in the preservation of the eco-system integrity.

It is necessary to plant the native plant types along of the watercourses in order to restore the damaged native coastline vegetation and to recreate the favorable ecological requirements (light and shadow) along of the watercourses. The aquatic and marginal plants should be planted on the adequate locations in order to prevent the watercourse pollution. It is necessary to use geo-textile membranes for the slope stabilization, which include the mixture of plant seeds, which stabilize and revegetate the slopes. It is very important for all locations along the highway and especially in the cuttings.

Review of the most significant impacts and prevention measures in relation to the flora are given for each section in LOT 2 in the following table 3.

Table 3. Significant impacts and prevention measures in relation to the flora for each section in LOT 2

1. SECTION: KARUŠE - MEDAKOVO	Site	• Penavino brdo on the right side of the alignment, 1 km from the starting point; • Matanovićevo brdo on the right side of the alignment 1.5 – 2.0 km from the starting point;.
	Plant community	• Communities of hornbeam and pubescent oak.
	The most important impacts	• Degradation or complete desrtuction of the vegetation due to the clearing of forest.
	Site	• Riparian zone of the river Tešanjka along all section of the alignment.
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive.

2. SECTION: MEDAKOVO - OZIMICA	Site	• Salkovića brijeg on the left side of the alignment at the distance of some 250 m from the alignment and 800 m from the starting point: • Križanovo brdo sa desne strane na udaljenosti od oko 100 m od trase i na udaljenosti od 1.0 do 1.5 km od polazne tačke.
	Plant community	• Community of ecosystems of hornbeam and pubescent oak
	The most important impacts	• Degradation or complete destruction of vegetation cover due to the clearing of the forest.
	Site	• Riparian zone of the Trebačka river at the distance of 2 km from the starting point in the form of the narrow discontinous belt; • Riparian zone of the river Strupinska between willages Čakrame and Ljubatovići.
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• Šiljati vrh on the left side of the alignment and just by the alignment, and at the distance from 10.0 to 12.0 km from the starting point..
	Plant community	• Bazophylle pine forests on serpentines
	The most important impacts	• Degradation of the vegetation and habitats of plant species and their communities distinguished by high conservation values.

3. SECTION: OZIMICA - POPRIKUŠE	Site	• Serpentine complex near Žepče, in the zone of Varošište and peak Kamenitovac (288 m), on the left side of the alignment.
	Plant community	• Xerophylle oak forests on serpentines • Heaths • Vegetation of rocks and rocky meadows
	The most important impacts	• Indirect impacts could be even more dangerous than direct ones, and their effects could have larger scope. At the sites where road allows access to the zones which have been relatively undisturbed by human activities, such is protected area near Žepče (wider area by the Papratnica brook), this could have long term effects and cause significant degradation of the quality of natural ecosystems.
	Site	• Riparian zone of the river Bosna and its tributaries in the zone from Brezovo polje to Golubinje.
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	4. SECTION: MEDAKOVO - OZIMICA Site	• By the river Bosna and its tributaries in the zone between Brezovo polje and Golubinje.
	Plant community	• Communities of hygrophylle forests and shrubs with sticky alder.
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

4. SECTION: POPRIKUŠE - NEMILA	Site	• Between 1.0 and 3.0 km from the beginning of the section, at sites Budakovac, Ravno brdo and Golubinjska šuma
	Plant community	• Communities of ecosystems of oak – hornbeam forests
	The most important impacts	• Construction of the highway will unavoidably lead to the clearing of the forests at site Saravački potok – Kočin potok, by the right side of the river Bosna where are developed communities of hornbeam and oak Carpino betuli – Quercetum roboris, which represent forests with the highest level of production in this area.
	Site	• Riparian zone of the river Bosna between Topčića polje and Hrašće at the site Ada (5.8 km from the beginning of the section)
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• By the river Bosna, from Topčića polje to Hrašće (3.5 km to 5.5 km of the section).
	Plant community	• Communities of the ecosystem of hygrophylle forests and shrubs of sticky alder.
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive.

5. SECTION: NEMILA – DONJA GRAČANICA	Site	• Allong all this section, on the both sides of the alignment.
	Plant community	• Community of ecosystems of oak – hornbeam forests
	The most important impacts	• Since in this section is planned construction of tunnels, there will be no any significant negative impacts on the flora, except in the vicinity of tunnel openings.
	Site	• Allong all this section, by the waterways, on the both sides of the alignment
	Plant community	• ecosystem of forests of white willow Salicetum albae • ecosystem of white and fragile willow Salicetum albae-fragilis • ecosystem of forests of willow and poplar Salici – Populetum • ecosystem of white and black poplar Populetum nigro-albae • ecosystem of forests of willow Salicetum triandrae • shrubs with willow Salicetum purpureae
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• Along all this section by the waterways, on the both sides of proposed alignment.
	Plant community	Forests of glossy buckthorn and sticky alder Frangulo alni- Alnetum glutinosae Forests of sticky alder in the continental areas Alnetum glutinosae montanum • Forests of sticky alder and sedges Carici elongatae-Alnetum glutinosae
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

6. SECTION: DONJA GRAČANICA - DRIVUŠA	Site	• From the settlement Donja Gračanica, via Ričica, Kopila, Klopča, to Perinog hana,
	Plant community	• Ecosystem kserotermnih šuma crnog graba i hrasta medunca
	The most important impacts	• Clearing of forests and habitat loss
	Site	• Riparian zone of the river Bosna and its tributaries
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

7. SECTION: DRIVUŠA - KAKANJ	Site	• On the slopes on the both sides of the alignment through morphostructure of Vijenac (Okruglo 749 m) to the south and the settlement Donji Lučani.
	Plant community	• Communities of ecosystems of oak and hornbeam forests
	The most important impacts	• Construction of the highway will unavoidably lead to the clearing of oak and hornbeam forests which represent a climatogenous vegetation in the hilly part of the central Bosnia and Herzegovina.
	Site	• Wider area of Gornji and Donji Lučani

	Plant community	• Communities of ecosystems of xerotherm forests of hornbeam and oak
	The most important impacts	• Construction of the highway will unavoidably lead to the clearing of oak and hornbeam forests which represent a climatogenous vegetation in the hilly part of the central Bosnia and Herzegovina.
	Site	• Right side of the river Bosna from Donji Lučani to Kakanj
	Plant community	• Communities of ecosystems of thermphylle forests of sycamore maple and hornbeam
	The most important impacts	• Construction of the highway will unavoidably lead to the clearing of hornbeam and sycamore maple.
	Site	• From Drivuša to settlement Klanci, and from Gornji Lučani to Kakanj, in the form of fragments on the flat areas by the river Bosna and its tributaries Tišina, Prihodi, Sopotnica, Klanji potok, Desetnički potok, and Ribnica
	Plant community	• Communities of ecosystems of hygrophylle forests of sessile oak and hornbeam
	The most important impacts	• Construction of the highway will unavoidably lead to the clearing of the forests of sessile oak and hornbeam.
	Site	• From Drivuša to settlement Klanci, and from Gornji Lučani to Kakanj, in the form of fragments on the flat areas by the river Bosna and its tributaries Tišina, Prihodi, Sopotnica, Klanji potok, Desetnički potok, and Ribnica
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• By the river Bosna and its tributaries Tišina, Prihodi, Sopotnica, Klanji potok, Desetnički potok, and Ribnica from Drivuša to settlement Klanci, and from Gornji Lučani to Kakanj.
	Plant community	• Communities of ecosystems of hygrophylle forests and shrubs with sticky alder.
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

8. SECTION: BLAŽUJ - TARČIN	Site	• In the zone of the waterways Trnava, Vidovac, Rakovica, Kremikovac, Krmeljevac, and Mlinčić, and Bijela rijeka and Kalašnica.
	Plant community	• Community of ecosystem of oak – hornbeam forests
	The most important impacts	• Construction of the highway will unavoidably lead to the clearing of oak and hornbeam forests which represent a climatogenous vegetation in the hilly part of the central Bosnia and Herzegovina
	9. SECTION: MEDAKOVO - OZIMICA Site	• Kuliješi – Bukovica – Zabrđe – Toplica.
	Plant community	• Communities of willows and poplars

	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• Narrow riparian zone in the southeast and flat aspects by the river Lepenica and its tributaries Zečji potok and Bukovina.
	Plant community	• Communities of ecosystems of white willow
	The most important impacts	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

1. SECTION: KARUŠE - MEDAKOVO	Site	• Penavino brdo on the right side of the alignment, 1 km from the starting point; • Matanovićevo brdo on the right side of the alignment 1.5 – 2.0 km from the starting point;.
	Plant community	• Communities of hornbeam and pubescent oak.
	Measures	• All trees should be cut to the standard lenght, cleared from all branhes. Trees suitable for market are all trees which could be used for production of timber. It would be necessary to obtain permit for setting the fire in accordance with existing legislation. All cut trees, branhes, and roots shoud be removed in accordance with existing regulations, rules, and provisions. • Prevention of uncontrolled falling of materials or intentional pushing of material down the slope. • Planting native species such as pubescent oak and hornbeam during finalization of alignment.
	Site	• Riparian zone of the river Tešanjka along all section of the alignment.
	Plant community	• Communities of ecosystems of white willow
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.

2. SECTION: MEDAKOVO - OZIMICA	Site	• Salkovića brijeg on the left side of the alignment at the distance of some 250 m from the alignment and 800 m from the starting point: • Križanovo brdo sa desne strane na udaljenosti od oko 100 m od trase i na udaljenosti od 1.0 do 1.5 km od polazne tačke.
	Plant community	• Community of ecosystems of hornbeam and pubescent oak
	Measures	• All trees should be cut to the standard lenght, cleared from all branhes. Trees suitable for market are all trees which could be used for production of timber. It would be necessary to obtain permit for setting the fire in accordance with existing legislation. All cut trees, branhes, and roots shoud be removed in accordance with existing regulations, rules, and provisions. • Prevention of uncontrolled falling of materials or intentional pushing of material down the slope. • Planting native species such as pubescent oak and hornbeam during finalization of alignment.
	Site	• Riparian zone of the Trebačka river at the distance of 2 km from the starting point in the form of the narrow discontinous belt; • Riparian zone of the river Strupinska between willages Čakrame and Ljubatovići.
	Plant community	• Communities of ecosystems of white willow
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.

	Site	• Šiljati vrh on the left side of the alignment and just by the alignment, and at the distance from 10.0 to 12.0 km from the starting point..
	Plant community	• Bazophylle pine forests on serpentines
	Measures	• Strict prohibition of overcutinng of the trees • It would be necessary to carefully perform planning, management and monitoring of tourist operation in protected area in order to ensure its long-term sustainability.

3. SECTION: OZIMICA - POPRIKUŠE	Site	• Serpentine complex near Žepče, in the zone of Varošište and peak Kamenitovac (288 m), on the left side of the alignment.
	Plant community	• Xerophylle oak forests on serpentines • Heaths • Vegetation of rocks and rocky meadows
	Measures	• Identification and strict prevention of destruction of protected flora, • Prohibition of overcutting of the trees.
	Site	• Riparian zone of the river Bosna and its tributaries in the zone from Brezovo polje to Golubinje.
	Plant community	• Communities of ecosystems of white willow
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.
	Site	• By the river Bosna and its tributaries in the zone between Brezovo polje and Golubinje.
	Plant community	• Communities of hygrophylle forests and shrubs with sticky alder.
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.

4. SECTION: POPRIKUŠE - NEMILA	Site	• Between 1.0 and 3.0 km from the beginning of the section, at sites Budakovac, Ravno brdo and Golubinjska šuma
	Plant community	• Communities of ecosystems of oak – hornbeam forests
	Measures	• Planting with native species such as oak and hornbeam.
	Site	• Riparian zone of the river Bosna between Topčića polje and Hrašće at the site Ada (5.8 km from the beginning of the section)
	Plant community	• Communities of ecosystems of white willow
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.
	Site	• By the river Bosna, from Topčića polje to Hrašće (3.5 km to 5.5 km of the section).
	Plant community	• Communities of the ecosystem of hygrophylle forests and shrubs of sticky alder.
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.

5. SECTION: NEMILA – DONJA GRAČANICA	Site	• Allong all this section, on the both sides of the alignment.
	Plant community	• Community of ecosystems of oak – hornbeam forests
	Measures	• Planting with native species such as oak and hornbeam. • All trees should be cut to the standard lenght, cleared from all branhes. Trees suitable for market are all trees which could be used for production of timber. It would be necessary to obtain permit for setting the fire in accordance with existing legislation. All cut trees, branhes, and roots shoud be removed in accordance with existing regulations, rules, and provisions.
	Site	• Allong all this section, by the waterways, on the both sides of the alignment
	Plant community	• ecosystem of forests of white willow Salicetum albae • ecosystem of white and fragile willow Salicetum albae-fragilis • ecosystem of forests of willow and poplar Salici – Populetum • ecosystem of white and black poplar Populetum nigro-albae • ecosystem of forests of willow Salicetum triandrae • shrubs with willow Salicetum purpureae
	Measures	• Planting with native species such as white willow, poplar, and sticky alder.
	Site	• Along all this section by the waterways, on the both sides of proposed alignment.
	Plant community	Forests of glossy buckthorn and sticky alder Frangulo alni- Alnetum glutinosae Forests of sticky alder in the continental areas Alnetum glutinosae montanum • Forests of sticky alder and sedges Carici elongatae-Alnetum glutinosae
	Measures	• Planting with native species such as glossy buckthorn and sticky alder.

6. SECTION: DONJA GRAČANICA - DRIVUŠA	Site	• From the settlement Donja Gračanica, via Ričica, Kopila, Klopča, to Perinog hana,
	Plant community	• Ecosystem kserotermnih šuma crnog graba i hrasta medunca
	Measures	• Clearing of forests and habitat loss
	Site	• Riparian zone of the river Bosna and its tributaries
	Plant community	• Communities of ecosystems of white willow
	Measures	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

7. SECTION: DRIVUŠA - KAKANJ	Site	• On the slopes on the both sides of the alignment through morphostructure of Vijenac (Okruglo 749 m) to the south and the settlement Donji Lučani.
	Plant community	• Communities of ecosystems of oak and hornbeam forests
	Measures	• Construction of the highway will unavoidably lead to the clearing of oak and hornbeam forests which represent a climatogenous vegetation in the hilly part of the central Bosnia and Herzegovina.
	Site	• Wider area of Gornji and Donji Lučani

	Plant community	• Communities of ecosystems of xerotherm forests of hornbeam and oak
	Measures	• Construction of the highway will unavoidably lead to the clearing of oak and hornbeam forests which represent a climatogenous vegetation in the hilly part of the central Bosnia and Herzegovina.
	Site	• Right side of the river Bosna from Donji Lučani to Kakanj
	Plant community	• Communities of ecosystems of thermphylle forests of sycamore maple and hornbeam
	Measures	• Construction of the highway will unavoidably lead to the clearing of hornbeam and sycamore maple.
	Site	• From Drivuša to settlement Klanci, and from Gornji Lučani to Kakanj, in the form of fragments on the flat areas by the river Bosna and its tributaries Tišina, Prihodi, Sopotnica, Klanji potok, Desetnički potok, and Ribnica
	Plant community	• Communities of ecosystems of hygrophylle forests of sessile oak and hornbeam
	Measures	• Construction of the highway will unavoidably lead to the clearing of the forests of sessile oak and hornbeam.
	Site	• From Drivuša to settlement Klanci, and from Gornji Lučani to Kakanj, in the form of fragments on the flat areas by the river Bosna and its tributaries Tišina, Prihodi, Sopotnica, Klanji potok, Desetnički potok, and Ribnica
	Plant community	• Communities of ecosystems of white willow
	Measures	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• By the river Bosna and its tributaries Tišina, Prihodi, Sopotnica, Klanji potok, Desetnički potok, and Ribnica from Drivuša to settlement Klanci, and from Gornji Lučani to Kakanj.
	Plant community	• Communities of ecosystems of hygrophylle forests and shrubs with sticky alder.
	Measures	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

8. SECTION: BLAŽUJ - TARČIN	Site	• In the zone of the waterways Trnava, Vidovac, Rakovica, Kremikovac, Krmeljevac, and Mlinčić, and Bijela rijeka and Kalašnica.
	Plant community	• Community of ecosystem of oak – hornbeam forests
	Measures	• Construction of the highway will unavoidably lead to the clearing of oak and hornbeam forests which represent a climatogenous vegetation in the hilly part of the central Bosnia and Herzegovina
	Site	• Kuliješi – Bukovica – Zabrđe – Toplica.
	Plant community	• Communities of willows and poplars

	Measures	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive
	Site	• Narrow riparian zone in the southeast and flat aspects by the river Lepenica and its tributaries Zečji potok and Bukovina.
	Plant community	• Communities of ecosystems of white willow
	Measures	• Loss of the vegetation and habitats of plant species and their communities which are distinguished by high conservation values and which are enlisted in Annex I of EU Habitat Directive

Protected natural areas

From the point of natural values protection, the most significant section of the motorway is the hairpin-bend complex which is especially developed in the zone of Papratnice, situated immediately by the proposed route on the left side, from the starting point of this section between the 7th and 8th km of the route. This area has been protected by the decision of the relevant authority of Žepče Municipality.

The hairpin-bends are subject to erosion and landslides. This process has been especially present on the locations where cutting of woods takes place, which is inevitable during the motorway construction. Because of that, very often large surfaces of bare land with rocks can be found at such locations. Plants grow on such surfaces and they are most important for hairpin-bends flora. Construction of the motorway can additionally endanger rare species developed in the area.

The protected area in the vicinity of Žepče has been established primarily for the purpose of preservation of the hair-pin bend complex which has very significant biological diversity and many endemic species of plants. The construction of the motorway will result in an increase of the number of visitors coming to this area who want to understand and appreciate the values of the protected area, and to gain some personal benefits.

Tourism in the protected area primarily depends on the preservation of the quality of the ecosystems. This is essential for the maintenance of the economy and life quality. Thus, it is necessary to carefully plan, manage and monitor tourism in the protected area in order to provide its long-term sustainability. Otherwise, negative impacts will occur.

Fauna and hunting

Data on composition of animal species on the analysed area of the motorway Vc alignment (Lot-2) was collected on the basis of conversations and consultations with the local inhabitants, while for additional data on the state of hunting game population, the hunting clubs from existing municipalities were consulted. In the data about fauna composition there is also data about hunting game, which as such presents the main and most distinctive part of fauna from the scientific as well as from expert point of view.

During preparation of the Study, those who elaborated the aspects of fauna and hunting, contacted the hunting representatives in the Public Company FES (Forest Economic Society) of the Zenica-

Doboj Canton, and hunting clubs: “Borje” Teslić, “Jeleč” Žepče, “Klek“ Zavidovići, “Zmajevac” Zenica, “ Zec and Stari Zec” Busovača, “Srndać” Kakanj, “Srndać” Visoko, “Bjelašnica” Sarajevo Canton (Blažuj-Tarčin) Hadžići, “Ljestarka” Kiseljak. During elaboration of data about fauna for each section of the LOT 2, data from Earth Museum from Sarajevo was used, and Hunting Clubs and local inhabitants were consulted. For the analysis of important species, the IUCN's Red List was applied, and recommendations of the Council Directive 92/43EEC.

On the basis of field visits (in July and September 2005) and by using the recommendations of European directives, the red list of IUCN, legal regulations on fauna in B&H, the situation by sections of the motorway was prepared.

Having in mind dense population, plants are still well protected, which means larger biodiversity of fauna in this area. 26 bird species have been identified, and for some of them, flying over this area is an integral part of their migrations, while others have nests in the area. Eight types of pigeons (mane pigeon, seagull, woodpecker, etc.) are protected species by Annexes II and III Council Directive 79/409EEC.
Besides birds, species of amphibians have been recorded in the swamp areas from Karuše to Ozimice. Well preserved forest habitats resulted with well developed game, both small and large. In section 8 there are wolves and bears and they occur in the sections around Zenica as well. Deers, boars, rabbits, foxes, pheasants and quails are frequently met. Protective measures do not anticipate a large number of passages for animals because the solutions which include tunnels, viaducts and bridges have significantly mitigated negative effects on the fragmentation of habitats and free migrations. The crossings for animals and protection fence are foreseen in the following stretches of the motorway:

- Chainage km 6+072,546 do 7+166,545
- Chainage km 17+465,017 do 18+304,836
- Chainage km 25+240,114 do 26+000
- Chainage km 46+388,80 do 49+122,716
- Chainage km 13+182 do 13+275,3
- Chainage km 19+100 – protection fence

Impact on fauna is considered individually for land and aquatic, so that the negativites are , first of all, determined by degradation of plant covering and impacts on abiotic conditions in water.

Fauna composition research results for the investigated parts of the alignment are shown in the following tables with impacts and mitigation measures.

Table 4. Fauna composition research results for the investigated parts of the alignment

SECTION 1. KARUŠE-MEDAKOVO	Site	Penavino hill from the right side of the alignment, 1.5-2 km from the starting point	**PROTECTION AND MITIGATION MEASURES**
	Fauna	Rare bird species, squirrels, rabbits	
	Impact	Moving or withdrawal of species due to the cutting of forest and loss of habitats, whereby the losses of individuals of certain species are expected	• Enable withdrawal of these species into the deeper parts of ecosystem, and installation of barriers in order to prevent their losses on the motorway, when they try to cross them
	Site	Usora River 0,207.684 km	• Fast rehabilitation of the vegetative cover (trees)
	Fauna	Endemic species of water moth *(Trichoptera)*	
	Impact	During removal of bank vegetation, vanishing of this specie can directly be caused, or even its dying.	
SECTION 2. MEDAKOVO-OZIMICE	Site	Part of the alignment with the plant communities Salkovića hill, Križanovo hill, Šiljati vrh (Sharp Peak), Tešanj – Crni vrh (Black Peak)	PROTECTION AND MITIGATION MEASURES
	Fauna	Birds: wryneck, quail, pheasant, squirrels, rabbits, foxes and wild boars	• Passages for large game in form of underpasses
	Impact	Moving or withdrawal of species due to the cutting of forest and loss of habitats, whereby the losses of individuals of certain species are expected	
	Site	River: Trebačka, 2km from the beginning of the section, Strupinska River between the Cakrame village and Ljubatovići	• Installation of net around the construction site and control of oil and lubricant leakage .
	Fauna	Birds, insects that are water dependant during the larva period	
	Impact	Rare bird specimens will move to the more peaceful parts due to the noise created during construction. During cutting of bank willow vegetation, there will be direct impacts on habitats and composition of fauna hydro-bionates, in water ecosystems, which shall lead to its degradation in this part of the watercourse	
SECTION 3. OZIMICE-POPRIKUŠE	Site	24+901,587 km to 34+000.00 km	**PROTECTION AND MITIGATION MEASURES**
	Fauna	• Birds: roller, swift, pigeon, quail, pheasant; • mammals: squirrels, rabbits, foxes and wild boars with dense populations	• passages for large animals and net to prevent crossing of small mammals, small houses for nesting birds.
	Impact	Moving or withdrawal of species due to the cutting of forest and loss of habitats, whereby the losses of individuals of certain species are expected	
	Site	Žepče surroundings	• Building of small houses for nesting birds due to removal of dendro-flora and enabling other species to change their flying corridor.
	Fauna	Birds	
	Impact	Due to general degradation of vegetative cover and noise, all species will withdraw to deeper parts of habitats, and this should be performed with the smallest possible losses	

SECTION 4. POPRIKUŠE-NEMILA	Site	From 38+617,44 km to 39+618.00 km	**PROTECTION AND MITIGATION MEASURES**
	Fauna	Rare specimens of birds, squirrels, rabbits, foxes	
	Impact	Moving or withdrawal of species due to the cutting of forest and loss of habitats, whereby the losses of individuals of certain species are expected	• Enabling unobstructed withdrawal of species by construction of paths and adequate management of the heavy machinery movement, with limited construction site. • Restoration of vegetation in the shortest period possible
	Site	Jezeračka mountain -Nemila	
	Fauna	Birds: type of pigeon *Columbia palumbas* which is protected specie according to the IUCN´s Red List and Bird Directive	• Precise identification of habitats and relocation of species to more favourable conditions
	Impact	Because of the construction works there is a possibility of species withdrawal, but also possible vanishing	
	Site	Bosna River	• Water at the construction site should be treated by sand filters, • Only after this treatment it can be discharged into the watercourse. • It would be necessary to fence the construction site with the 2 m high fence. • At certain moment you cannot make up for the cut bank vegetation, and it is thus necessary to additionally plant new trees, which would result in adequate management of the fauna at the bottom.
	Fauna	Important place within the aquatic fauna belongs to the densely populated colony of cyprinid type of fish, while in the other part of aquatic fauna, the dipterous insects are dominant, sparsely bristled animals, and leech as typical inhabitants of polluted running water	
	Impact	Because of the construction works, the excess situations are possible, leakage of lubricants, oil, or sliding of land which will probably condition the losses of aquatic fauna or their movement, which is especially related to ichthyo-populations	

SECTION 5. NEMILA-DONJA GRAČANICA	Site	Vranduk km 50+000 -51+000	**PROTECTION AND MITIGATION MEASURES**
	Fauna	Birds: gull, pigeon, *Otus scopus* i *Cuculus canorus*. The type of gull registered in this area is one of the protected species according to the European Directive – Annex II – III, rare specimens of small game.	• Construction of small houses for nesting, which would enable undisturbed reproduction of nesting birds populations. • Installation of nets in order to prevent passage of these small animals, which would to some degree mitigate negative effects on these populations.
	Impact	Due to construction works there is a possibility of losing some species and not having enough space for nests.	

SECTION 6. DONJA GRAČANICA-DRIVUŠA	Site	Bosna River bank zone	**PROTECTION AND MITIGATION MEASURES**
	Fauna	Rare specimens of birds, ducks Water fauna: well developed cyprind fish fauna, aquatic species of insects, rare specimens of crayfish, leech, snails	• Water at the construction site should be treated by sand filters, • Only after this treatment it can be discharged into the watercourse. • It would be necessary to fence the construction site with the 2 m high fence. • At certain moment you cannot make up for the cut bank vegetation, and it is thus necessary to additionally plant new trees, which would result in adequate management of the fauna at the bottom.
	Impact	Because of the motorway construction there is a possibility of bank erosion and covering of sediments, changes in the composition of zoo benthos, which will impact the change in composition and numerosity of ichthyo-populations	
	Site	Zenica (60+000 to 64+000)	• Enable withdrawal of birds to

	Fauna	Birds: gull, *Pluvialis apricaria, Corcius garrulus and Otus scopus*	
	Impact	Withdrawal of birds to other habitats with smaller losses	

SECTION 7. DRIVUŠA-KAKANJ	Site	Kakanj from 75+000 to 80+000 km – Bosna River bank	**PROTECTION AND MITIGATION MEASURES**
	Fauna	Migratory bird types: gull, pigeon, magpie, wryneck, swift	For the nesting birds, construction of small houses, and for other species enabling of their unobstructed withdrawal and change in the movement corridor
	Impact	Cutting of the flying corridor and its changes	
	Site	Vijenac (Okrugla) – Donji Lučani – oak and hornbeam forest	• Construction of underpass or "green bridge" for crossing of larger game • For smaller game, nets should be installed along the motorway in order to prevent their coming out to the motorway.
	Fauna	Squirrels, rabbits, quails, pheasants, rare specimens of reptiles	
	Impact	Fragmentation of habitats, which will until the adaptation time indicate destruction of a larger number of individuals	
	Site	Bosna River with smaller tributaries	• should be treated by sand filters, • Only after this treatment it can be discharged into the watercourse. • It would be necessary to fence the construction site with the 2 m high fence. • At certain moment you cannot make up for the cut bank vegetation, and it is thus necessary to additionally plant new trees, which would result in adequate management of the fauna at the bottom.
	Fauna	Cyprinid fish types, barbel, sparsely bristled animals, leeches, dipterous insects	
	Impact	Because of the motorway construction, negative impacts on water ecosystems of Bosna River as well as of the streams flowing into this watercourse are possible, which will initiate movement of aquatic fauna	

SECTION 8. BLAŽUJ-TARČIN	Site	Lepenica	**MJERE ZAŠTITE I UBLAŽAVANJA UTJECAJA**
	Fauna	Water fauna: Trout, Miller's thumb, water moth, large diversity of water flowers, wheateater, crayfish	• Water at the construction site should be treated by sand filters, • Only after this treatment it can be discharged into the watercourse. • It would be necessary to fence the construction site with the 2 m high fence. • At certain moment you cannot make up for the cut bank vegetation, and it is thus necessary to additionally plant new trees, which would result in adequate management of the fauna at the bottom.
	Impact	Because of the degradation of bank vegetation the movement of water insects or their vanishing is possible, and also sliding of land is possible and changes in the composition of zoo benthos, which can cause disappearance of movement of ichthyo-populations.	
	Site	Bijela River – crossroads Tarčin-Kreševo	• If possible, avoid works near the watercourse.
	Fauna	Appearance of crayfish, which is according to the IUCN´s Red List the rare and endangered species	
	Impact	Species very sensitive to the anthropogenic impacts and every activity can initiate its vanishing	
	Site	Blažuj	• Due to the cutting of dendro-flora, fast revitalisation is necessary • Small houses for nesting birds

	Fauna	Birds flying over this area: eagle-owl, bee-eater	
		Cutting of the flying corridor	

Note:
In the measures for fauna protection, in form of green bridge, underpass, nets on the motorway, small houses for birds, precise location cannot be determined (in meters). During the motorway construction the monitoring will also be performed, and geologists will, according to the character of geological ground and other abiotic conditions, be able to determine the exact location in the field, and any premature judgment would be too audacious and not objective.

Also, data about impacts on aquatic fauna at places where the alignment is crossing over the watercourses are shown in the following table with mitigation measures.

Table 5. Impacts on aquatic fauna at places where the alignment is crossing over the watercourses

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Section 1. Karuše – Medakovo Km 0+000 – 4+000			The food source is being reduced for the aquatic organisms and habitats of water insects disappear by river training of the riverbed due to the removal of the vegetation. Due to the works that follow the bridge construction The additional covering and filling the riverbeds will occur which will have significant impact on the composition and numerosity of fauna. This impact reflects in the form of direct stress that will directly and indirectly have impact on reduction of populations or disappearance of the individuals of especially sensitive species. Removal of coastal vegetation, mining and similar. Can cause additional losses of microhabitats Due to operation of large marines, there is a possibility of	• First and only mitigation measure during the construction is limited construction that will be fenced with net, • The control of the oil and petroleum discharge which must not be poured out into the watercourses • River training should provide revitalization of the coastal vegetation and prevent and additional covering of the riverbed ➢ Provide easy passage for fish species (rare) regulated with smaller paths and similar
Km 0 +750 to 4+250	Balnjača Luke Village Tešanjka River	River training length L= 3,605 m – riverbed trained with the reno mattresses		
Km 0+877.410	Bridge on Tešanjka River	Concrete bridge		
Km 1+763, 190	Bridge on Tešanjka River	Concrete bridge		
Km 3+121,860	Bridge on Tešanjka River	Concrete bridge		
Section 2. Medakovo – Ozimica Km 4+000 – 24+876,40				
Km 4+600 to 4+800	Obrenovac Trebačka River	River training length L= 200 m – riverbed trained with the reno mattresses		
Km 5+000 to 5+200	Obrenovac Trebačka River	River training length L= 180 m – riverbed trained with the reno mattresses		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 5+900 to 6+100	Bare Trebačka River	River training length L= 239 m – riverbed trained with the reno mattresses	discharge of oil or petroleum into the river course and it can lead to change of abiotic conditions that will initiate withdrawal of hydro bionates toward the lower parts of watercourses and what is necessary to provide	
Km 6+900 to 7+100	Toplik Trebačka River	River training length L= 215 m – riverbed trained with the reno mattresses		
Km 6+917.00	Bridge on Trebačka River	Concrete bridge		
Km 8+500 to 8+800	Dolac Trebačka River	River training length L= 320 m – riverbed trained with the reno mattresses		
Km 9+150 to 9+350	Luke Trebačka River	River training length L= 215 m – riverbed trained with the reno mattresses		
Km 10+150 to 12+820	Karadaglije Trebačka River	River training length 2890 m - riverbed trained with the reno mattresses		
Km 10+840	Čaglići Trebačka River	Concrete bridge		
Km 11+046	Čaglići Trebačka River	Concrete bridge		
Km 11+611	Zaimovići – Alispahići Trebačka River	Concrete bridge		
Km 12+748	Karadaglije Trebačka River	Concrete bridge		
Km 16+050	Mladoševica – Stupina Strupinski stream	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 16+730	Mladoševica – Stupina Strupinski stream	Concrete bridge		
Km 17+980 to 18+340	Galovac Strupinski stream	River training length L=373 m - riverbed trained with the reno mattresses		
Km 18+950 to 19+850	Galovac Strupinski stream	River training length L=940 m - riverbed trained with the reno mattresses		
Km 20+150 to 20+250	Ljubatovići Strupinski stream	River training length L=110 m - riverbed trained with the reno mattresses		
Km 21+150 to 21+400	Ljubatovići Strupinski stream	River training length L=230 m - riverbed trained with the reno mattresses		
Km 21+650 – 22+000	Bečkića selišće Strupinski stream	River training length L=390 m - riverbed trained with the reno mattresses		
Km 22+650 to 22+980	Bečkića selišće Strupinski stream	River training length L=350 m - riverbed trained with the reno mattresses		
Km 23+269,90	Ozimica Liješnica River	Concrete bridge		
Km 23+668	Bečkića selišće - Ozimica Strupinski stream	River training length L=348 m - Ozimička petlja and L= 60m Goliješka petlja - riverbed trained with the reno mattresses Concrete bridge		
Section 3 **Ozimica – Poprikuše** **Km 24+876,40 – 37+740**				
Km 28+026,440	Tatarbudžak Stream 50	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 28+676,440	Tatarbudžak Stream 51	Concrete bridge		
Km 28+876,440	Tatarbudžak Stream 52	Concrete bridge		
Km 29+626,440	Vašarište – Bljuva Bljuva Stream	Concrete bridge		
Km 32+026,440	Papratnica Ljubna River	Concrete bridge		
Km 32+526,440	Papratnica Papratnica River	Concrete bridge		
Section 4 Poprikuše – Nemila Km 37+740 – 46+388,80				
Km 41+690	Kahrimani Sarevački stream	Concrete bridge		
Km 42+970	Topčić field Stream 63	Concrete bridge		
Km 43+170	Topčić field Kočin stream	Concrete bridge		
Km 46+090	Orahovačko field Krivača River	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Section 5. Poprikuše – Nemila Km 46+388,80 – 58+434,60				
Km 46+500	Orahovačko field Stream 71	Concrete bridge		
Km 46+800	Nemila Repeljski stream	Concrete bridge		
Km 47+000	Nemila Selački stream	Concrete bridge		
Km 47+540	Nemila Stream 75	Concrete bridge		
Km 47+670	Nemila Stream 76	Concrete bridge		
Km 56+300	Vranduk Stream 80	Concrete bridge		
Km 56+650	Vranduk Jelovik Stream	Concrete bridge		
Km 57+860	Donja Gračanica Gračanička River	Concrete bridge		
Section 6. Donja Gračanica – Drivuša Km 58+434,60-66+941,10				
Km 58+537,350	Donja Gračanica Suha River	Concrete bridge		
Km 59+640	Zenica - Dobra voda	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 61+036	Zenica – Kopilo Babina River	Concrete bridge		
Km 64+540	Zenica – Perin Han Stijenčice Stream	Concrete bridge		
Km 65+580	Zenica – Perin Han Stream 87	Concrete bridge		
Km 65+690	Zenica – Perin Han Đulanova River	Concrete bridge		
Section 7. Drivuša - Kakanj Km 66+941,10 – 82+121,10				
Km 67+691 to 67+941	Drivuša Bosna River	River training length L= 250 m – riverbed trained with the reno mattresses		
Km 68+321,10	Janjići Prihodi Stream	Concrete bridge		
Km 75+537,30	Modrinje Repovačk i Stream			
Section 8. Blažuj – Tarčin Km 0+000 – 18+885,40				
Km 1+770	Vlakovo – crossing Kulićev Stream	Concrete bridge		
Km 4+050	Kobiljača – Rudnik Rakovica River	Concrete bridge		

Motorway chainage	Location/ watercourse	Length and the way of watercourse training/ Bridge on the watercourse	Expected impact on waters	Mitigation measures during the construction site preparation and motorway construction
Km 4+700 – 5+750	Rakovica Kremikovac Stream	River training length L= 850 m – concrete riverbed		
Km 7+400	Azapovići Stream 109	Concrete bridge		
Km 9+300	Kulješ Stream 113	Concrete bridge		
Km 10+720	Donji Bojakovići Stream 114	Viaduct		
Km 11+120	Solaković Stream 115	Concrete bridge		
Km 11+950	Zabrđe – Mokrine Mlinčići Stream	Viaduct		
Km 12+675	Zabrđe – Mokrine Stream 117	Concrete bridge		
Km 13+037.890	Zabrđe Tisovački Stream	Concrete bridge		
Km 18+330	Tarčin Mlavica Stream	Concrete bridge		
Km 18+300 to 18+500	Tarčin Bijela River	River training length L= 230 m – riverbed trained with the reno mattresses		
Km 18+512	Tarčin Korča River	Concrete bridge		

For the protection of water flows which in the hydrosphere cycle provide the main supply of underground waters, monitoring has been planned, which includes a biological component (fit-benthos, macro-invertebrate and ihtio-population).

Landscape

Guidelines presented in the environmental study for “the Corridor Vc Motorway“is the basis for informing the public. It is necessary to make possible communication with the interested parties, including the needs of the community which is one of the very important elements.

The public, which is an integral part of the environment, should be stimulated in the project design stage in order to receive proposals and suggestions on time. Environmental study encompasses three areas which treat the issues of landscape form:

Due to the increase of the level of material and social development, researches and measures which refer to the form and protection of landscape presented in the Study are becoming a need and long-term interest of the population and communal and political institutions. Because of that, implementation of goals and tasks in this project can be successfully implemented only through active participation of all interested parties. Main guidelines of the landscape form around the motorway and its fitting into the existing surrounding area have been presented in the study.

This was done by taking care for the protection of natural and ambient values. The landscape shaped in this way will provide clarity of the route, safe traffic and meeting of functional and aesthetic requirements.

It is obvious that the route of the motorway is very significant for the environment. Consequences of the impact are most frequently manifested as damage to the environment, decrease or destroying of some parts of the landscape. Environmental study precisely identifies the possibilities of such manifestations and the protective measures.

Negative impacts on the settlements located in the vicinity of the motorway are manifested as noise, dust, pollutants, wind etc. For all these negative impacts, adequate protective measures have been presented. Special attention has been paid to identification of different categories of the existing natural resources and their preservation.

The protection in the form of green areas around the special-purpose facilities in the vicinity of the route (hospitals, schools, residential and public buildings, etc.) has been planned.

Environmental study includes landscape shaping of newly created leisure locations for different purposes (rest areas, dividing lanes, intersections, motels, gas stations and car parks). Regardless of the type of green area, these surfaces complement and enrich the existing plant population. Some of them may be picnic areas for passive and active recreation of the population in the nearby settlements.

Environmental impacts during construction stage caused by measures and acts of construction organization and technology

Construction of a motorway is a large and significant technical operation in the landscape followed by different, mainly intensive impacts on the environment: impacts on population, air, water, land, flora and fauna, cultural, historical and natural heritage, landscape, microclimate, etc. Organizational and technical measures are available for avoiding or mitigating these impacts.

Obligation of the Investor is to select the contractor with a clearly defined policy of good-quality management (product, environment and health management) approved in practice (approved by certificate and everyday work) and to perform transfer of environmental responsibility to the contractor. The key requirement and important criterion for the selection of a specific contractor is the development of complete and good Project of technology and organization of implementation of motorway construction works, which would include all necessary studies, solutions, annexes and documents.

Such project, besides the usual items, has to contain an assessment made by the contractor of the impact on the environment during the construction stage of the motorway – based on findings and recommendations of the environmental study – with detailed description of the measures and list of needed funds, with a note who will implement the measures.

This means that specific WORK RULES and detailed MANUALS should be defined at the level of the construction site, which provides that the goals established in the good-quality management are fulfilled. Such project of technology and organization of construction works should be revised by the relevant professional institution, approved by the developer of the study and project documentation and officially approved by the investor, as an integral part of the contract on handing over the works.

Relevant governmental authorities should demand from the contractor a complete project of technology and organization of construction works in order to issue suitable urban consents for all preparation works, that is technical solutions for the protection of the environment during the work implementation stage on the basis of which inspection monitoring during the construction will be made.

Air quality

Concentrations of polluting materials along the route are result of emission (traffic and background sources), meteorological parameters and terrain configuration. Measures of polluting material in the atmosphere, which will be incorporated into the Study, were done with software for emission calculations and concentration of polluting materials close to motorways MLuS 02 (calibrated in Germany). Recommended program values were used as input data since relevant data about air quality in subject area where neither relevant nor reliable. For the sections where modeling was done, the values used were those for highly polluted (rural) environment. With assumed values of a specific vehicles emission for 2008, above mentioned is considered a pessimistic scenario.

Other input parameters (road category, PGDS, percentage of heavy vehicles in traffic, alignment gradient, technical characteristics of a tunnels and climatology data) were adopted from relevant planning study made for design Motorway in a Vc Corridor.
Modeling was done for the section with biggest average annual (daily) traffic (PGDS) and at location relatively densely inhabited and close to tunnel portal[4]. After analyzing the results of modeling air quality on section Lašva krak1-Kakanj end at location Donja Gračanica, following can be concluded:

- There is no need for further calculations since results appear to be in accordance with regulations for the section with biggest PGDS and location which is in the zone of enlarged concentration of polluting materials. Building on abovementioned it can be concluded that regulations are satisfied for the whole area subject of analysis (area close to motorway route in a Corridor Vc – Lot 2.)
- Traffic on a Motorway in Corridor Vc – Lot 2 should not influence the concentration of polluting material in the area close to future motorway route with negative impact on health of a people who live in analyzed area.
- It is reasonable to assume that in short terms standard values concerning human health could be exceeded for LČ10 and NO2, and only in areas with high background pollution in the vicinity of future motorway and especially close to tunnel portals. Individual residential buildings would then have to be protected with sound barriers which lower diffusion of emitted polluting material and tunnels should have to be supplied with vertical ventilation tubes.
- It is possible that acceptable limits air quality concerning ecosystem protection for NOx might be exceeded. However, this standard cannot be applied to the areas in a vicinity of the motorway, which were analyzed in this study.

It is worth mentioning that pollution of air and soil with lead is not likely to happen because Law on air protection (Official Gazette FB&H) prohibits usage of gasoline with lead in FB&H after January 1, 2010.
In cases where it was not possible during design to include measures which contribute to prevention of impacts from vehicles to air quality[5] i.e. in sections/locations where influence is unavoidable, following measures must be introduced:

- Designing of sound barriers, which at the same time lower diffusion of emitted polluting material;
- Designing of vertical ventilation tubes in tunnels in order to decrease concentration of polluting material at tunnel portals;
- Introducing stricter speed limit in areas with high background concentration;
- Planting of dense green vegetation in area between road and houses in order to filter the pollutants.

Locations where above-mentioned measures are to be taken into account are shown in table 1.

In a period of exploitation:

Growth of PGDS for 3,20% to 5,60% per year is predicted in a period 2013. - 2042. At the same time, concentration of polluting material should not follow the growth of PGDS having in mind

[4] Higer concentration is usual for vicinity of tunnel portals because emmissons are acumulated inside tunnels.
[5] Capacity designing in order to avoid traffic jams and suden changes in driving regime, chosing of routes, placement of interchanges and tunnel tubes close to settlements, schools and working places etc.

further development of motorcar technology, expanding need for alternative fuels and standards in force for new vehicles concerning gases emission.

In any case, constant monitoring of polluting material is recommended, as a basic protective measure during exploitation of corridor Vc. Monitoring should be done in accordance with Monitoring rule-book, at all locations where motorway runs through settlements, in sections with bigger alignment gradient and PGDS and in a vicinity of tunnel portals.

When monitoring area in LOT 2, locations shown in Table 1.2 should be considered as wider choice. Concentration of LČ10 and NO_2 depends on wind direction and strength. This implies that it is important to take position of settlements into consideration in a relation with wind rose when selecting monitoring locations on motorway.

Table 6. Locations for consideration regarding stated mitigation measures [6]

SECTION	CHAINAGE	LOCATION
1: KARUŠE - MEDAKOVO	0+450 DO 1+200	TEŠANJKA
	2+250 DO 2+800	LUKE
	3+525	PETLJA MEDAKOVO
	4+000 DO 5+070	OBRENOVAC
2: MEDAKOVO - OZIMICA	11+300 DO 12+880	KOPRIVCI
		KARADAGLIJE
	23+300 DO 24+400	OZIMICA
	28+600 DO 29+700	TATARBUDŽAK
3: OZIMICA - POPRIKUŠE	31+770 DO 32+120	ROSULJE
	32+350 DO 32+600	
	37+200 DO 37+810	POPRIKUŠE
	41+390 DO 43+560	TOPČIĆ POLJE
4: POPRIKUŠE - NEMILA	45+450 DO 45+610	
	46+040 DO 46+120	NEMILA
	46+200 DO 46+390	
	46+390 DO 47+070	NEMILA
	47+130 DO 47+800	
5: NEMILA - DONJA GRAČANICA	51+200 DO 51+850	VRANDUK
	52+150 DO 52+600	PONIRAK
	57+630 DO 58+540	DONJA GRAČANICA
	58+530 DO 58+830	DONJA
	59+150 DO 59+920	GRAČANICA
6: DONJA GRAČANICA - DRIVUŠA	62+900 DO 63+420	KRČEVINE
	63+730 DO 67+060	DRIVUŠA
7: DRIVUŠA - KAKANJ	67+060 DO 67+600	DRIVUŠA
	68+450 DO 69+370	JANJIĆI
	72+650 DO 74+350	LUČANI
		BILJEŠEVO
	77+700 DO 79+400	KRIVAČE
	79+400 DO 80+950	DUMANAC

[6] Ove lokacije primarno porediti sa lokacijama na kojima su predviđeni zidovi za zaštitu od buke, te ukoliko isti nisu predviđeni, sprovesti neku drugu mjeru zaštite.

8: BLAŽUJ (VLAKOVO) - LEPENICA	80+950 DO 82+260	KARAULSKO POLJE SLIVNICE
	1+500 DO 5+750	ŠAMIN GAJ RAKOVICA
	9+060 DO 9+570	HOMOLJ PETLJA LEPENICA
9: LEPENICA - TARČIN	11+200 DO 13+500	BOJAKOVIĆI SOLAKOVIĆI BUKOVICA ZABRĐE
	13+800 DO 14+230	TOPLICA
	18+240 DO 18+710	TARČIN

Final selection of locations and their number and means available will be in accordance with laws in force.

During motorway construction, following can be proposed:

- Spraying of non-paved access roads with water
- Covering of trucks that transport material
- Limiting the speed on non-paved (access) roads
- Avoiding idling of mechanization
- Using modern and efficient mechanization.

Socio-economic analysis

Socio-economic analysis made within Study is divided into 2 parts:

Socio-economic propositions – Detailed examination of influenced area, demographic settlement characteristics and analysis of economic parameters. A main characteristic for the analyzed area is the densest concentration of settlements and inhabitants. Area under direct influence includes 93 settlements located in 9 municipalities (Maglaj, Usora, Tešanj, Žepče, Zenica, Kakanj, Ilidža, Hadžići, Kiseljak). According to estimate 132.322 inhabitants lived in the area under direct influence in 2004.

Zonal plans and Municipality development plans are thoroughly presented on Background for Documentation of the Plan – LOT 2. This document is completed together with the Study for further phases of zonal plans preparation. Area of Zenica-Doboj, Srednja Bosna and Sarajevo cantons, through which motorway route in a Corridor Vc runs are areas with highest level of economic development: Gross production value and (GDP), modern indicator of economic development.

Structure of employment in these three cantons, according to standardized field classification, shows the highest percentage of employment in industry 47.253 (53.3% in FB&H, and 28,8% in analyzed area), commerce 25.329 (16,9% in analyzed area), public administration and services 19.096 (10,7%% in analyzed area), and education 16.636. Traffic and connections employ 14.710 workers which amounts to 53% of employed in traffic for whole FB&H.

Socio-economic influence from motorway in Corridor Vc construction – analysis of influence from construction and utilization: Motorway construction in analyzed area will increase the speed of a traffic flow, division of traffic and other changes which can be expected along motorway and at locations where interchanges will be constructed.

New motorways could foster separation/division of local communities and severing traditional traffic lines. Alternate routes for local transport could become longer after motorway is constructed, which directly affects business and non-mechanized transport. Whether urban or rural, the existing transportation routes should remain in function where possible. In rural areas, existing normal connections between villages and fields could be interrupted, so construction of underpasses or over-bridges should be considered.

Tenth chapter in document Background for Documentation of the Plan - LOT 2 pinpoints measures addressing the avoidance of or decreasing of abovementioned possible conflicts. Interchanges position, space collisions with motorway route and meeting the needs for traffic connections have been analyzed.
Relatively high number of waterways regulations and displacement of local roads was analyzed together with construction of high number of de-leveled passages between local inhabitants and regional roads or arable areas. Further, specific locations at chosen motorway route in Corridor Vc – LOT 2 are shown:

Because of technical solution for route in the edge part of Nemila settlement (Sector II), which consists from connected tunnels, interchange construction is under question mark. Position of neighbor interchanges (Poprikuše and D. Gračanica), justifies further analyses.

Sector III is bypass around Zenica regional center (administrative center of Zenica-Doboj canton). In the vicinity of adopted motorway route, there is relatively high number of individual residential houses. Due to conceptual change in design solution on connection between motorway route and existing road in Drivuše area (relocation of section in collision is proposed), construction of proposed semi-interchange Lašva – branch2, in Janjići settlement is being rethought. Adopted route in Preliminary solution was changed in Lepenica location, following request from Kiseljak municipality and due to the vicinity of a primary school. Because of cemetery location in Toplica settlement (municipality Kiseljak), it is necessary to construct short tunnel instead of deep cut which was foreseen in Preliminary design. Further, concerning the fact that social unity of settlements is disturbed and large number of residential houses is endangered with positions of Ozimica and Donja Gračanica interchanges, it is advisable to change micro locations of these interchanges.

Finally, positions of existing and planned infrastructure facilities (overhead transmission lines, gas pipelines and telecommunication capacities) have been analyzed. Conflicts with future motorway route are identified and recommendations are being made. Construction of a motorway should result in a rational connection between B&H regions and neighboring countries and regions, and should help foster stabilization and development of our country. Improvements of transport conditions will improve life quality which will be manifested through:

- Decreased road lengths and shorter traveling time for goods and passengers;
- Lower transport expenses for both goods and passengers;
- Increase in employment in different branches
- Increase in value in geo-traffic sense for B&H
- Increase in competitiveness of B&H economy in the gravity area of the corridor;
- Start of new projects and enlargement of private investment in regional economy;

- Improved access to markets for goods transported through future motorway in the Corridor Vc
- Improved access to work and more employment posts;
- Decrease of accidents with pedestrian involvement and related socio-economic expenses due to decrease of current overlapping transit and local traffic;
- Positive influence to the houses and business in the vicinity of motorway route related to easier access due to displacement of high intensity traffic away;
- Business opportunities for local companies in sectors of road construction, transport, exploitation and raw material processing (rocks, pebbles, cement, asphalt etc.)
- Construction works will open short termed and farfetched working opportunities.

On the other hand, project will have some negative implications, especially local society-economic influences:

- Loss of houses and property (agricultural land and forest)
- Limited private land exploitation
- Losses in agricultural production (loosing of smaller incomes and arable land could influence household economy)
- Decrease of resident property values due to vicinity of motorway, which is globally known effect from construction of big transport infrastructure structures
- Influences to a business/industry due to conflict with motorway route.

Infrastructure systems

Through motorway route selection and design, potential area conflict with infrastructure systems and utilities was solved, i.e. suggestions where given for locations where measures must be undertaken in order to avoid these conflicts.

Motorway route was chosen with respect to all criteria set, avoiding where possible areas planned for water accumulations like Toplice accumulation and water protection area in municipalities Tešanj and Maglaj. Route alignment is made in accordance with elevations of maximum gradient on hydro-energy structures on river Bosna. Further, the attention was paid to motorway influences on city water supply primary structures in Zenica and Žepče. Route is in accordance to reservoir position and city system purifiers. Locations where motorway route leads through rural areas, with big number of smaller-individual and rural water supply systems, are identified as possible conflict points. This primarily applies to municipalities of Maglaj and Kiseljak. In these areas, problem of route crossing over smaller supply pipelines requires application of certain technical solutions of pipelines' relocation through delevelled local roads passages.

All electro-magnetic capacities, high voltage transformer stations and distributive transmission lines are identified. Existing high voltage overhead transmission lines of 400 kV, 220 kV, 110 kV and 35 kV, intersect with motorway corridor area. Reconstruction of these overhead transmission lines could be required according to security and technical regulations.

A natural gas pipeline exists in the observed area of municipalities Kakanj and Zenica through which runs the part of motorway. Zonal natural gas pipeline Semizovac – Kakanj – Zenica L=54km runs along the existing M17 route in the region of Kakanj (on the right-hand side facing in the direction of Zenica). In the region of Karaula and Donji Kakanj it crosses to the right bank of river

Bosna and across notch Mioc enters into area of municipality Zenica, place Perin-Han. In this municipality the pipeline and planned route of the motorway cross at several points at the section Perin-Han – Crkvica which will have to be dealt with accordingly in IDEJNI PROJEKAT by solving collision points of motorway and natural gas pipeline.
Natural gas pipeline branch for the supply of towns in Northern Bosnia is planned. There is planned introduction of Gas supply for the city of Kiseljak and primary Gas pipeline is planned to run along the existing regional road Blažuj - Kiseljak. Routes of all planned pipelines must be made in accordance with adopted motorway route.

Analyzed area is covered by two different systems for mobile and wired phone services. Part of the observed area is covered by Eronet provider. As there are many points of collision of phone wiring and planned motorway route it requires minor reconstructions in volume and occasional reconstructions and protections at the interchanges which also applies to all other telecommunication wiring. At the planning and design of new telecommunication capacities the locations must be made in accordance with planned motorway route. This applies for all Base Transceiving Stations including the ones in tunnels. Having in mind the fact that all roads intersect with motorway in two levels it is estimated that telecommunication cables would not have to be reallocated and all what will need to be done is providing additional protection for them. Already installed telecommunication wiring is mostly placed along the existing roads.

Climatology characteristics

Climatology of the LOT 2 – sector is relatively favorable. Influence from moderate continental climate from “Pannonian plain” follows River Bosna valley all the way to Sarajevo basin. This is the reason why the change of temperature according to altitude is smaller than usual. Change of the annual middle temperature from Doboj to Tarcin is 2,5^{o}C, although the altitude difference is 514m. This can also be applied to other meteorological parameters related to elevation.

Regime of precipitations is different for different locations. The driest area is Zenica basin related to surrounding relief, although in other areas the sum of precipitation is related to altitude. In Zenica basin the intensity of precipitations is smaller. Relief of this sector is extremely complicated, and some parameters like meteorological conditions, differ at different locations in the sector. In canyons (stretch Maglaj-Vranduk tunnel and wider area of Lasva river mouth-Visoko) the biggest problems are fog and decreased visibility, together with dew, ice on the pavement end other effects due to increased humidity. Danger arising from above described is vehicles sliding on the motorway.

In basins and cuttings, winds are stronger, so adequate protection must be designed. At these locations, daily temperature amplitude is bigger due to stronger insulation, especially during winter when difference between morning and max daily temperature reaches 18-20^{o}C. This is also very important in a respect to snow and ice melting, and sharp shifts from shade to sunny areas.

Apart from fog, visibility is often affected by sunlight blindness, especially during winter time due to low sun position, and depending to direction of motorway route and disposition of motorway structures.

Noise protection

Motorway noise comes from 4 sources: (a) vehicles (b) friction between vehicles and motorway pavement (c) drivers' behavior and (d) construction and maintenance. Noise from vehicles comes from engine activity, transmission, exhaust, differential system and is most intensive at speeding up on the uphill sections, using engine to break, on poorly maintained roads, and during "stop and go" traffic conditions. Poor maintenance of motor vehicles contributes to increased noise level on the roads. Motorway noise is the result of the friction on the contact point of the vehicle wheel and road surface and contributes to overall traffic noise emission. Noise level depends on tire and road surface condition. Friction noise is very high at high speeds and breaking. Drivers' behavior contributes to the increase in noise by using sirens, playing loud music, kick-starting and intensive breaking. Building and maintenance require the use of heavy construction vehicles which during use increases to noise level

Until today there are no legally defined noise levels in Bosnia and Herzegovina or in any of the entities who are in charge of environmental protection. Therefore, the rules and regulations used are those of canton Sarajevo.

Traffic on the motorway will result in high levels of noise emission due to planned PGDS. Noise level during night will exceed standard value of 50dB (A) in the vicinity of the motorway. The noise will have negative impact on settlements surrounding the planned motorway route. Knowing that rural settlements along the planned route have both residential and commercial character it will be classified as IV Zone. Therefore, in this study the acceptable levels of noise used are 60 dB (A) during the day and 50 dB (A) during the night. In cases when object or objects belong to groups I, II or III the noise levels corresponding to respective groups were used. Standards of 60/50 dB(A) applied are comparable to those of WHO and regulations for the EU countries.

For estimate of noise impact, night level noises were used as criteria being generally more restrictive than daytime levels. Contour noise lines during the night are represented in Noise maps. Results represent noise impact on objects placed in the vicinity of the motorway. Noise maps resemble two scenarios. First scenario represents Noise map in the situation without protective measures introduced and other represents the situation with protective measures introduced.

Noise map without protective measures defined possible length of acoustic wall in inhabited areas endangered by noise levels since the noise levels are higher than the standards for the nighttime. Noise map without protective measures is made upon the calculation analyzing situation with 2D and 3D models for the planned motorway route containing characteristics of both terrain and route. Motorway characteristics represent defining daytime and nighttime traffic and standard used for calculation of noise levels. PGDS is taken over from the Traffic study as well as the relationship between daytime and nighttime traffic and percentage of heavy vehicles in daytime traffic.

Tabele 7. Necessary measures for mitigation of noise impact

SECTION	CHAINAGE (KM)	WALL AT THE RIGHT SIDE OF THE MOTORWAY[7]		WALL AT THE LEFT SIDE OF THE MOTORWAY		AREA OF THE WALL (M2)	RECOMMENDED NUMBER OF STRUCTURES FOR PASSIVE PROTECTION
		WALL HEIGHT (M)	WALL LENGHT (M)	WALL HEIGHT (M)	WALL LENGHT (M)		
	0+81,5-0+191	1-5	109,5	--	--	438	
	0+010-0+150	--	--	1-5	140,0	530	
	0+455,5-0+646,5	1-5	152	--	--	600	
	0+485-1+144	--	--	1-5	659	2678	
	0+785-1+199	1-5	414	--	--	1943	
SECTION I	1+590-1+770	--	--	1-5	180	630	17
0+000-04+000 KM	2+324-2+590	--	--	1-5	266	1237	
	2+220-3+280	1-5	1060	--	--	3610	
	3+280-5+152,5	1-5	1872,5	--	--	7307,5	
	3+699-4+075	--	--	1-5	376	1662	
	4+243,5-4+812,5	--	--	1-5	569,5	2470,5	
	5+175-5+664,5	--	--	1-5	489,5	2407,5	
	7+804-8+064	1-5	260	--	--	1180	
	8-900-10+280	1-5	1380	--	--	3330	
	9+367-9+567	--	--	1-5	200	900	
	9+596-9+676	--	--	1-5	80	340	
	10+153-10+191,5	--	--	1-5	38,5	192,5	
	10+271-10+949	1-5	678	--	--	2895	
	11+007-11+107	1-5	100	--	--	100	
	11+205-11+825	1-5	620	--	--	2950	
SECTION II	10+414-10+745	--	--	1-5	331	1210	133
04+000-24+901 KM	11+197-12+037	--	--	1-5	840	3980	
	17+037-17+237	1-5	200	--	--	600	
	17+437-17+808	1-5	371	--	--	1629,5	
	17+929-18+849	1-5	920	--	--	4220	
	18+900-19+300	1-5	400	--	--	1840	
	19+308-19+688	1-5	380	--	--	1800	
	16+764-16+824	--	--	1-5	60	300	
	16+888-16+988	--	--	1-5	100	340	
	17+090-17+264	--	--	1-5	174	810	
	18+020-18+620	--	--	1-5	600	2410	
	18+647-19+444	--	--	1-5	797	3502,5	
	19+695-19+935	--	--	1-5	240	1200	
	20+166-20+226	--	--	1-5	60	300	
	20+445-20+705	--	--	1-5	260	1270	
	20+745-20+845	--	--	1-5	100	490	
SECTION II	21+120-21+676	--	--	1-5	556	2334	
04+000-24+901 KM	21+676-22+036	1-5	360	--	--	1680	
	22+680-23+011	1-5	331	--	--	1153	
	23+010-24+750	1-5	1740	--	--	7170	

[7] Direction follows the chainage of the road.

	21+520-22+089	--	--	1-5	569	2680,5	
	22+200-22+520	--	--	1-5	320	1270	
	22+830-23+350	--	--	1-5	520	1840	
	23+359-24+659	--	--	1-5	1300	5660	
	27+849-28+501	3	652	--	--	1956	
	28+649-29+724	3	1075	--	--	3225	
	31+776-32+130	3	354	--	--	1062	
	32+336-32+612	3	276	--	--	828	
	32+926-33+266	3	340	--	--	1020	
	35+376-35+630	3	254	--	--	762	
SECTION III	37+376-37+839	3	463	--	--	1389	82
24+876-37+726	24+890-26+008	--	--	3	1118	3354	
	26+250-26+768	--	--	3	518	1554	
	27+856-28+506	--	--	3	650	1950	
	28+600-29+748	--	--	3	1148	3444	
	31+750-32+103	--	--	3	353	1059	
	32+336-32+610	--	--	3	274	822	
	32+880-33+300	--	--	3	420	1260	
	35+120-35+547	--	--	3	427	1281	
	37+199-37+752	--	--	3	553	1659	
	41+390-42+488	3	1196	--	--	3588	
	42+660-43+488	3	828	--	--	2484	
SECTION IV	43+870-44+241	3	371	--	--	1113	16
38+617-46+289 KM	46+040-47+062	3	1022	--	--	3066	
	46+964-46+972	3	8	--	--	24	
	47+022-48+768	3	1746	--	--	5238	
	49+988-50+304	3	316	--	--	948	
	51+269-51+787	3	518	--	--	1554	
SECTION V	54+944-55+113	3	169	--	--	507	70
46+289-58+434 KM	55+992-56+646	3	654	--	--	1962	
	57+516-58+733	3	1217	--	--	3651	
	58+311-58+733	--	--	3	422	1266	
	57+553-58+275	--	--	3	742	2226	
	51+212-52+504	--	--	3	1292	3876	
	59+053-59+868	3	815	--	--	2445	
	59+908-60+166	3	258	--	--	774	
	60+169-60+554	3	388	--	--	1164	
	60+899-61+600	3	701	--	--	2103	
	61+678-61+896	3	218	--	--	654	
	62+804-63+342	3	538	--	--	1614	
	63+476-67+070	3	3594	--	--	10782	
SECTION VI	59+908-60+166	--	--	3	258	774	108
58+434-66+959 KM	60+169-60+562	--	--	3	393	1179	
	61+113-61+589	--	--	3	476	1428	
	61+670-61+888	--	--	3	218	654	
	62+804-63+342	--	--	3	538	1614	
	63+930-65+352	--	--	3	1422	4266	
	65+517-66+401	--	--	3	884	2652	
	66+568-66+981	--	--	3	413	1239	
	66+864-68+669	3	1835	--	--	5505	
	68+701-69+266	3	565	--	--	1695	
	72+530-74+388	3	1858	--	--	5574	
	74+597-75+744	3	1147	--	--	3441	

	76+597-77+315	3	718	--	--	2154	
	78+092-79+023	3	931	--	--	2793	
SECTION VII	79+148-81+614	3	2466	--	--	7398	145
66+959-82+559 KM	66+857-67+665	--	--	3	808	2424	
	69+064-69+295	--	--	3	231	693	
	72+404-74+403	--	--	3	1999	5997	
	75+578-76+273	--	--	3	695	2085	
	77+440-80+108	--	--	3	2668	8004	
	80+738-81+850	--	--	3	1112	3336	
	1+510-2+540	3	1030	--	--	3090	
	2+680-3+043	3	363	--	--	1089	
	3+225-5+894	3	2669	--	--	8007	
	6+010-6+363	3	353	--	--	1059	
	7+185-8+131	3	946	--	--	2838	
	9+080-9+868	3	788	--	--	2364	
	10+140-12+231	3	2091	--	--	6273	
	12+405-14+239	3	1834	--	--	5502	
	18+240-18+717	3	477	--	--	1431	
SECTION VIII	1+450-3+946	--	--	3	2496	7488	158
0+000-18+800 KM	4+153-5+000	--	--	3	847	2541	
	5+105-5+602	--	--	3	497	1491	
	7+185-8+131	--	--	3	946	2838	
	9+250-9+848	--	--	3	598	1794	
	10+140-10+881	--	--	3	741	2223	
	11+302-12+989	--	--	3	1687	5061	
	13+110-13+684	--	--	3	574	1722	
	18+240-118+717	--	--	3	477	1431	

Motorway management and monitoring system

Although detailed analysis and sometimes even calculations have been done, some of the environmental impact estimates, which were basis for design solutions, could be unreliable. Further, environmental conditions change in time and so does the environmental legislature. This is the reason why some of the planned measures for decrease of environmental impacts, could turn out to be insufficient or even not applied. Therefore, the state institutions are tasked with organization of environmental monitoring. Strictly, the monitoring means following of pollutant emission (to air, water etc) and changes in environmental parameters (quality of air, noise level, river water quality, changes in soil quality etc.) In wider sense, it includes monitoring of social-economic parameters, like motorway influence to inhabitants migration for example. Aim of monitoring system is control of all systems influencing the environment quality (motorway water purification, maintenance of these devices, regularity in a case of accident (leak of chemicals on the motorway etc.). Additional organizational and investment measures are taken on a basis of monitoring results.

Monitoring is with multiple purposes: (i) managing, (ii) data obtaining, including basis for planning and (iii) scientific purpose. Monitoring can be done in a real time, when information must be submitted and used promptly (accident), or through annul reports for last year. Monitoring project is not a precondition for Environmental Permit issuing, but is necessary for tendering on construction financing and motorway maintenance. Impacts to the motorway are followed by impacts to surrounding and could be classified as favorable, necessary and unfavorable. Favorable impacts are planned changes in landscaping including motorway, and wider economic effects. Necessary effects are, for example, excepted changes in purpose of fertile soils or acceptable level of noise.

Unfavorable impacts are oil leaking into a river during accidents, air pollution over acceptable limits or deforestication during construction.

Monitoring should identify:

1. State in the moment of Study on Environmental Impacts preparation,
2. State in the moment of construction works beginning,
3. State in the moment of construction works finish, and
4. State during exploitation.

This practically means that monitoring system must be established instantly. Of course, the system can not start with full capacity, since it is not built yet, but must be designed and developed from the beginning, having in mind institutions responsible for its start, functioning and data dissemination. It is obvious that responsibility falls on state institutions (body in charged for motorway project in general and state institutions in charged with environmental protection. The whole system can be divided into three phases: Zero state monitoring, Monitoring in a phase of construction and Monitoring in a phase of motorway exploitation.

Monitoring does not include only parameters following, but also following the state institutions' capability to organize monitoring and dissemination of results.

Zero state monitoring should follow the conditions in a period between Study preparation and start of construction. It should: (i) point out whether any of environmental parameters have changed in an unpredicted way prior to the construction, and (ii) to obtain additional basis for Main design preparation, and to define the environmental conditions, necessary for construction permit issuing. Zero state monitoring should particularly include:

- Changes in area purposes (plans and physical changes): plans for construction of auxiliary and alternative roads, changes in area and town-planning documents, construction or removal of important structures,
- Water,
- Soil,
- Eco-systems.

Monitoring in a phase of construction is related to the period between planning and site preparation to the end of construction works**.** It includes the influences in the phase of material preparation within the corridor area, transportation of material and mechanization, and construction (impacts from mechanization work and maintenance and consequences from these impacts). Monitoring expenses should be included in motorway construction expenses. Essential is the presence of archeologist during construction. All areas where archeologist presence is necessary during construction are marked in a Study.

Monitoring in a phase of motorway exploitation should include:

- Following of socio-economic parameters' changing (indicators) related to motorway wider area (changes in number of inhabitants, development of settlements close to motorway, changes in economic development parameters),
- Following of possible changes in water supply and possible water pollution
- Following of soil quality and possible soil pollution
- Following of air quality and ambient noise

Cycles of environmental quality insurance is finished, and new one starts with responsibilities and actions by state institution in charged with motorway management. This primarily includes monitoring functions in prevention of ice on motorway pavement, cleaning of snow, maintenance of motorway water purifiers, organization and maintenance of emergency systems etc.

This system must start functioning from the moment of Study adoption, and state institutions in charged of monitoring must be clearly identified. Of course, the system can not start with full capacity, but it is important that it starts functioning and develops itself in time. If this does not happen, Studies on environmental protection might seem to be made only for procedural formalities, and not in order to provide sustainable development of motorway corridor area nor of State.

Measures connected to transportation conditions by accidents

Environmental impacts in most cases are considered to be continuous events (e.g. pollution of air by fuel combustion in engines). However, accidents may also occur and significant impacts on the surroundings may occur in a very short period of time. Accidents may be natural or caused by humans. Also, the accidents may occur on the road or outside of it. They may cause damages of different proportions. They can not be fully avoided and it is necessary to manage them through Risk management. Procedure for the risk includes: (i) risk assessment, (ii) risk management, and (iii) risk communication.

In the case of a motorway, the accidents may be connected to: (i) usage of the motorway, and (ii) activities which are implemented in the immediate surroundings of the motorway. Use of a motorway results in accidents which can be caused by the following: inadequate driving conditions which are not in accordance with features of the road, traffic conditions or weather conditions, fatigue of the driver, including other conditions which influence quality of driving, and lack of adaptation of traffic conditions to the specific load which is transported. Risk is higher on bridges, overpasses and underpasses, and especially in tunnels. Here, it is necessary to pay special attention during the design phase of the road, and in case of longer tunnels a special risk management programme should be made which includes constant monitoring and a team for prevention of accidents and fast reaction.

The issue of traffic accidents is one of significant criteria which describe the relation between planned options of motorway with respect to environment. Detailed research of the issue of traffic accidents has to be done within traffic research and for the purpose of comparing optional solutions in the Technical study phase. The presented data show that the planned motorway has a very high degree of traffic safety and that environmental impacts are within the allowed limits for such a facility.

The planned motorway has been identified as a road used for intensive transport of dangerous materials because it connects areas of international significance. Dangerous materials mean such materials which are very toxic, can oxidize, explosive, ecologically toxic, combustible, self-combustible, and otherwise dangerous for people and the environment. Every road has some role in transport of dangerous materials due to its position in a network, and possible consequences are especially important in biologically valuable areas and in locations with concentrated traffic flow, which is one of the characteristics of the planned motorway.

Activities in the immediate surroundings of the motorway are connected to accidents which can be caused by: (i) industry in the motorway influential area (ii) operation of facilities (petrol stations etc.) along the motorway. Type of industry in the motorway influential area requires transport of special materials, from liquid fuels and oils to specific chemicals. It is necessary to assess risks for every potential material transported, and for working conditions of industrial and other plants outside the road, and to have recovery measures in case of accident (funds and responsibilities). Besides transport which is performed on the motorway, it is necessary to identify and analyze the process of handling liquid fuel at petrol and natural gas stations.

Pollution that can be a consequence of operation of such facilities is constant and determined relatively by time and space, and it is primarily the result of: fuel spillage, operation of systems for washing of vehicles (automatic and manual), depositing of exhaust gases, wearing out of tires, load spillage, disposal of organic and inorganic waste. Accidents which may occur at the site of petrol and natural gas stations as a result of accidents with vehicles which transport petrol derivatives or accidents when fuel is poured happen rarely and it is very difficult to quantify them precisely. A special problem is the fact that these are almost immediate, very high concentrations that can not be anticipated either in terms of space or time. Also, accidental spillage during the process of pouring of fuel at petrol stations should be taken into account. In order to prevent petrol derivate from damaging the surroundings, it is necessary to remove the pollutant. The removal should be one of the petrol station's environmental protection measures.

Having in mind other countries' experience, it is necessary to define conditions for: selection of adequate absorbent; purchase, transport and storing of absorbent; application of absorbent; method of collection after application; regeneration (if absorbent is regenerative); disposal of absorbent. Having in mind the above mentioned, it is necessary to ensure that the laws which refer to transport of dangerous materials are obeyed (law on transport of dangerous materials (Official Gazette RBH 13/94, Rules on the way of transport of dangerous materials in road traffic (Official Gazette RBH 13/94)), as well as international guidelines on transport of dangerous materials. In case of accident it is necessary to inform the police. On the road, there should be information on telephones for calling the police, ambulance and fire brigade, including an arrangement with telecom companies on constant coverage of the route by GSM signal. The police, ambulance and fire brigade should be in contact with utility and other companies (even scientific) on the ways of cooperation and acting in case of accident in accordance with the prescribed and practiced procedures. Fire brigades have to have information on special features of the load in the accident in order to provide a suitable response. The police, ambulance and fire brigade should know general phrases of safety and risk (S and R phrases) in order to be ready to react in case of accident.

Large industrial plants are situated in the motorway zone, especially in the towns of Zenica and Kakanj. These plants require a lot of transport (railway and motorway), but these are mainly internal materials (ore, iron products, coal, ash, slag,). Transport vehicles can slow down traffic and increase the need for overtaking. Also, since this section includes an arterial railway, it is necessary to encourage transport by railway.

The biggest risk of environmental accident is the result of possible spillage of harmful/poisonous materials into water flows (and afterwards land). One example is uncontrolled spillage of fuel and oil which are used for the operation of construction machines and vehicles. There is no efficient (reliable) measure for reduction of such impact, but there is general technological discipline, strict monitoring of the implementation of safety measures by the contractor (its managerial staff). However, reduction of impact can be implemented by informing all concerned parties situated downstream from the location of an accident, in order to implement preventive measures, before

the polluted spillage reaches them – afterwards, curative measures should be introduced (filtering etc.).

An organization project should anticipate the system of reaction in the case of accidents and disasters, and to ensure the necessary means for dealing with it: communication, first aid, efficient transport vehicles and suitable channels/ways for emergency transport of intervention teams or injured people.

Conclusion

Analysis of Environmental conditions was made within Environmental Impact Study, including documentation on Initial estimate of environmental impact, in accordance with Environmental law, Official gazette FB&H No. 33/03, and corresponding rule books. These analyses are necessary for issuing of town-planning permit and they identify:

(a) measures for area conflict avoiding due to motorway route selection

(b) measures for environmental impact decrease and following of law requirements during motorway construction and exploitation.

Proposed measures within this Study must be followed by everybody involved in project in phases of:

(i) further design documentation making (designer),
(ii) period between issuing of environmental permit to start of construction works (state institution responsible for construction and motorway maintenance),
(iii) during construction (institution in charged with contracting of works, construction operations and inspections) and
(iv) after the construction (state institution responsible for motorway construction and maintenance).

Prior to the construction, Investor must provide Construction Permit. Apart from proofs on fulfillment of demands from town-planning permit, Investor must present:

(v) results on zero state monitoring,
(vi) Landscaping and horticulture design.

During construction, inspections should

(vii) monitor the application of environmental protection measures (organizational and technical) identified within the Study.

Request for Construction Permit must include Zero State Monitoring, changes and additions to the Study due to the results obtained during zero state monitoring.